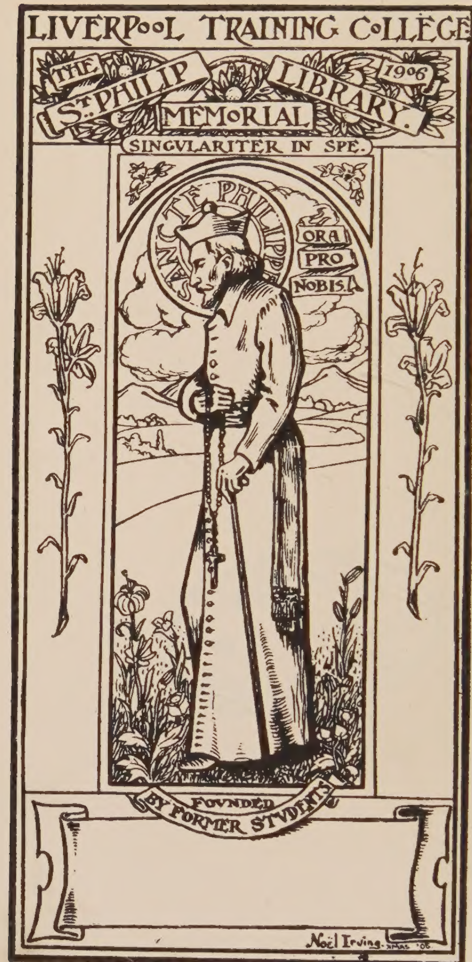
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THE CHURCH AND SCIENCE

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BY

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Scientia sine caritate inflat ; caritas sine scientia aberrat ;
scientia cum caritate aedificat

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1917

TO

HIS EMINENCE

CARDINAL GASQUET, O.S.B.

THIS BOOK

WITH HIS PERMISSION

IS DEDICATED

IN TOKEN OF AN OLD UNBROKEN

AND MUCH-VALUED

FRIENDSHIP

PREFACE

THIS is not what is commonly called a work of reconciliation; it is rather one of delimitation and explanation. Its first object is to present an outline of the attitude of Science to-day towards various problems, physical and biological, and to show how very few of these problems come in any way into contact with dogmatic religion. If some writers were to be believed, there exists and must always exist between the Church and Science so fundamental and inexorable an enmity that it is utterly impossible for any person honestly to serve both. That such is not the case is proved by scores of instances which need not here be insisted upon. Another of the chief objects of this book is to show why this is so, and incidentally to make clear how wide a range for speculation the Church permits—even, for example, on such a subject as the interpretation of the first chapter of Genesis.

On the other hand, no attempt has been made to minimise the teachings of the Church, nor is it denied that there are points where her teaching and the theories of certain men of science come into direct conflict. But a further object of the book is to make it clear that these are theories, at present unproved and perhaps insusceptible of convincing proof; that scores and scores of such theories have been put forward and will continue to be put forward; that scores and scores of them have been thrown on the scrap-heap of abandoned ideas, whither others will follow them; and that the believer in Christianity may possess his soul in patience, well aware that no theory which is really in opposition to revelation can be true.

In compiling this work the author has naturally consulted and utilised many scores of books, to whose authors he now expresses his grateful acknowledgements. He has received much assistance from kind friends. To Father Maher, D.LIT., S.J., who has read the entire book in MS., and to A. J. Rahilly, M.A., B.SC., who has read the greater part of it, his thanks are specially due for the trouble which they have taken and for the valuable assistance which they have given him. Sir Oliver Lodge, F.R.S., and Professor J. Joly, F.R.S., were also good enough to help him in connection with special points, but these gentlemen, needless to say, are in no way committed to or responsible for the substance of the book. The Most Rev. Dr. Cohalan, Bishop of Cork, and the Right Rev. Abbot Bergh, O.S.B., also assisted with advice, and Mr. James Britten, K.S.G., has been good enough to make various suggestions whilst the work was passing through the press. To all these the author's thanks are due and are most sincerely rendered.

The author has at times made raids upon works of his own where subjects of an identical character were under discussion and where he did not see his way to improve on his earlier statements. It is a great source of satisfaction to him to know that the sections dealing with theological and philosophical matters have been carefully examined by more than one competent critic. That these sections have been seen and approved leads him to hope that he may not have gone astray in regions with which he is necessarily only superficially acquainted. All such theological and philosophical statements are, as far as he is concerned, made subject to correction.

B. C. A. W.

UNIVERSITY COLLEGE, CORK.
December, 1916.

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THE CHURCH AND SCIENCE

CHAPTER I

SCIENCE: ITS SCOPE AND LIMITS

WHEN one starts upon a task such as that with which this book is concerned, one cannot but be struck by two considerations. In the first place, their objects being so different, why should there be any need to state, still less to attempt to adjust, the relations existing between the Church and Science? That such need must exist is proved by the vast number of books which have been written with no other object than that just mentioned. Their number, in fact, is the second of the two considerations alluded to above. With regard to these points a few words may be said, leaving their further consideration to be treated in the succeeding pages.

The Church is unaltering in her doctrines—in the essence of the inner meanings of her doctrines at any rate, however much her comprehension of the bearings of some of them on extrinsic problems may gradually come to be enlarged. But this is not to say that in doubtful matters, fringing greater questions as to which her opinion has never been otherwise than definite, the accredited exponents of her doctrine may not and do not pass from one opinion to another in view of new facts and discoveries.

In dubiis libertas is a part of her motto often forgotten by her adversaries, who are never tired of picturing her to their public alternately as a fossilised organisation incapable of any intellectual life and, on the other hand, as torn by fierce and internecine quarrels as to questions of doctrine.

As a matter of fact, they fail to grasp the difference between articles of faith and minor items as to which no decision has ever been given and on which every Catholic is entitled to form his own opinion. On such points, as every student of history knows, there have been violent and, it may even be admitted, at times unseemly controversies. And controversies there are to the present day, but not respecting the dogmas of the Church, as defined in her creeds and in other definite and authentic pronouncements. From this point of view of course she is unchanging. It can scarcely seem reasonable to any thinking person that, if a Divine Revelation were given to man, it should not be perfectly definite as to those points which must be held by those who wish to save their souls by it. We are not now arguing the case for a Revelation ; that is the province of other writers. In this particular work we assume the fact that a Revelation has been made to man and that the Catholic Church is its custodian and the judge of what is meant by any particular doctrine.

This book is not a compendium of Apologetics ; it deals with a special branch of the subject, and with that alone. This statement is made lest it should be supposed that we are here assuming the very point which we ought to set out to prove, namely, the position and authority of the Church. Our position, on the contrary, is briefly this : assuming that the Church is what she claims to be, what are the exact relations which she bears to the science of the day and those which the science of the day bears towards her ? Having thus defined the exact scope of this book, it may be well to define the terms which we have just been employing, on the excellent principle that we should be quite clear as to what we are talking about before we begin to talk about it.

The subjects under discussion in this book are the Church and Science. For our present purposes we may equate the Church and Religion, and speak, as so many others have done, of the relations between Science and Religion.

These two terms, then, come first before us for consideration and definition. Inseparably connected with them is yet a third term, that of Philosophy, which must by

no means be omitted from this preliminary consideration, if only because so much confusion exists outside the Church—perhaps indeed within it in the case of her less-instructed members—as to the true relations between the Scholastic Philosophy and Scholastic Theology. As they form the framework of this book, these three terms must necessarily appear time and again in it, nor can their connections and limitations be fully developed save by a gradual process. But, even though this be so, the ground must be broken by some general observations before, in the words of the Scottish legal phrase, we can "condescend to particulars."

Like many other terms which are constantly on our tongues, the term SCIENCE is one which bears to-day a very different significance, and, it may be added, a very much narrower significance, than that which it once possessed. When Milton, for example, spoke in his "Areopagitica" of "the seven liberall sciences," he did not mean what we should mean to-day. He was alluding to the two classical groupings of learning—the "Trivium," consisting of Grammar, Logic, and Rhetoric, and the "Quadrivium," consisting of Arithmetic, Music, Geometry, and Astronomy. Now it is clear that in this classification there are included a number of subjects which would never rise to the mind to-day when the term science is used, such as Grammar, Rhetoric, and Music, which last, though it involves scientific principles no doubt, would still be reckoned by us rather among the arts than among the sciences. For the term science has become narrowed down to that form of knowledge which deals with the observation of phenomena—to what in truth is really Physical Science, in which we include such branches as Physics, Chemistry, and Biology, with all their numerous sub-divisions. Sir Norman Lockyer sums up the work of Science, as thus understood, quite fully and quite adequately when he says that "The work of the true man of science is a perpetual striving after a better and closer knowledge of the planet on which his lot is cast, and of the universe in the vastness of which that planet is lost."

First and foremost, then, Science deals with ascertained facts. Some might even be inclined to limit its sphere to

the collection, classification, and proximate explanation[1] of facts, and to assert that, when scientific men desert that narrow path, they stray into the fields of philosophy. Of this more in a moment, but with regard to these "facts"—and far more, let it be parenthetically said, with regard to these philosophisings—if it is not already known to the reader—it will become abundantly clear, as he makes his way through this book, that Science has been constantly changing her mind both as to facts and as to the philosophical conclusions derivable from them. In the nature of things, since we can only arrive at unrevealed knowledge step by step, this must be so; but it helps us to understand a consideration mentioned at the commencement of this chapter and left for fuller consideration until the argument had been sufficiently developed.

We were considering why the positions of the Church and of Science towards one another required re-stating so frequently as it would appear that they do. That this is largely due to the fluctuating nature of scientific opinion, the *necessarily* fluctuating character of that opinion, will become abundantly obvious to any reader of this book.

Apart, however, from the collection of facts, Science is concerned, and, as will be seen shortly, necessarily and usefully concerned in forming deductions from the facts which she has collected, in fact of philosophising from them. This exceedingly important branch of her work is also very highly contentious and brings science into touch with other branches of knowledge and other realms of thought. It was chiefly, though of course not by any means only of this aspect of science that Huxley was thinking when he wrote: "Science is, I believe, nothing but trained and organised common sense."[2] Science observes the facts of nature by means of the senses, aided nowadays by all sorts of truly marvellous pieces of apparatus, such as the telescope and microscope. So much have we come to rely on these aids that it is difficult for those unacquainted with

[1] By "proximate explanation" is meant the reduction of facts under general laws; whereas philosophising proper is the tracing them back to ultimate or transcendental causes, causes which lie beyond the range of material experience.

[2] In one of his "Lay Sermons."

scientific history to suppose it possible for any real progress to have been made without them. Yet Tycho Brahe established an observatory on a little island near Elsinore, made memorable to us by "Hamlet," an observatory which was very remarkable as being destitute of a telescope, and this for the very excellent reason that that instrument had not then been invented. Of course he had other and even elaborate apparatus with which he made extraordinarily accurate observations, but he had no telescope. Yet it was on the observations thus made that the great discoveries of Kepler and the epoch-making conclusions of Newton were founded. With or without instruments Science makes observations out of doors and in laboratories where, with the aid of apparatus of almost inconceivable delicacy and ingenuity, she endeavours to wrest her secrets from nature.

The ascertainment and verification of facts is the object of the observations of which we have just been speaking. When collected they must be sorted out and arranged. It is found that some of them fall into definite categories; classification can now be effected. Then, as already stated, deductions come to be made and so-called "Laws of Nature" are formulated. It must be noted, however, that the enormous, almost incredible growth of science during the past half-century has brought about an extreme specialisation which if inevitable is none the less regrettable. Time was, and that only a few years ago, when there were many real biologists working in the field of science. Nowadays these are divided up into Zoologists, Botanists, Geologists, Physiologists, Bio-Chemists, and so on, each knowing but little of any subject save that included in his own specialty. And within these specialties are others even more minute. Every reading person will remember the late Oliver Wendell Holmes's "Scarabee"—the enthusiast who would not call himself an entomologist, hardly even a coleopterist, but who would go to his grave quite contentedly if he could solve the question as to whether "the *Pediculus Melittæ* is or is not the larva of *Meloe*." The writer in question was, as some people are prone to forget, a teacher of science, and knew what he was talking about: his satire is hardly

an exaggeration. Another thing which must be noted respecting the growth of specialisation in biological science is the divorce which it has brought about between field and laboratory work, though an exception should be made in the case of geology. This has led the laboratory workers, who are the enormous majority, rather to look upon the field worker as an amateur, in spite of the great memories of Darwin and Wallace. Such is the fashion of the day. And the laboratory workers are undoubtedly too prone to forget that the prime fact about living nature is that it is alive. For the most part in their laboratories they study dead nature, and very naturally they come to dwell, for the most part, on its attributes when dead. For example, how many persons who read about the characters and chemical aspects of protoplasm have it really borne in upon their minds that most of the things which we know about that very important substance, and all the things which we know about its chemistry, are known about dead protoplasm, and are to be accepted with that reservation?

We may grant that the extreme specialisation to which we have alluded has resulted in a wonderful progress in scientific knowledge, but we are obliged also to admit that it cannot but have a narrowing effect upon the specialisers: since, after all, the human mind will always consider that the problems upon which it is engaged surpass in importance all others, and in consequence will conclude that the "laws" which appear to be detectable in its own branch of work must also exercise an overmastering power over those who may endeavour to take a wider survey of scientific ideas.

And, of course, when it comes to philosophising, it is obvious that little which is of any value in that direction can be accomplished by any one who cannot take a fairly comprehensive view of the general facts of science.

These moralisations respecting the effect of specialisation on science may perhaps be pardoned because they certainly tend to explain some of the curious statements made from time to time by very eminent specialists.

But the main point which we had before us when this

digression was entered upon, was the methodology of Science. As we have seen, this consists in the observation of natural facts by the use of the unaided or aided senses and by experiments of all kinds; of the classification of the facts thus laid hold upon; and, finally, of the codification of the laws which seem to guide the operations of nature.

With all its wide scope and its many conquests, it must not be forgotten that Science does not cover the whole field of knowledge. Enthusiastic writers—usually not themselves great authorities in any branch of science but rather exponents to the populace of other persons' work, on the principle that "there is nothing like leather"—seem sometimes to forget this fact, but it is none the less true. As just stated, whether we study science or literature, or comparative mythology, or whatever it may be, we are all of us prone to consider the studies in which we are engrossed as of paramount importance. We are constantly exposed to the temptation of imagining that in our own line of study is to be found the key which will unlock all the secret chambers of the universe when we shall have discovered how to fit it into the wards. When one considers all the circumstances this is a perfectly natural obsession; but none the less it *is* an obsession, as we shall see if we look at the matter a little more closely.

In the first place, confining ourselves for the moment to the obvious limitations of Science, it is clear that there are a whole range of common experiences which are totally outside the sphere of scientific study. Sir Oliver Lodge in his address to the British Association,[1] dealt with this aspect of the case as follows: "The fact is that some of the best things are, by abstraction, excluded from Science, though not from Literature and Poetry; hence perhaps an ancient mistrust or dislike of science, typified by the Promethean legend. Science is systematised and *metrical* knowledge, and in regions where measurement cannot be applied it has small scope; or, as

[1] Also published as "Continuity," London, Dent, 1913, under which caption it will be quoted in these pages: this quotation is from p. 12.

Mr. Balfour said the other day at the opening of a new wing of the National Physical Laboratory, 'Science depends on measurement, and things not measurable are therefore excluded, or tend to be excluded, from its attention. But Life and Beauty and Happiness are not measurable.' And then characteristically he adds: 'If there could be a unit of happiness, Politics might begin to be scientific.'"

There is, however, another limitation which does not so readily occur to the mind of the general reader.

Before beginning her work Science must make her Act of Faith. She must recite her Credo as to the reality of the things with which she has to do; in the reality of the External World and not less in the Uniformity of its Processes. On this point it may be well to say a few words.

Perhaps the most awkward and difficult question of Philosophy is that which asks: "What ground have I for believing in the existence of a Material World outside of, and independent of, my own thought?" The Absolute Sceptic (philosophically speaking) would reply that there are no grounds and that all that we think that we observe is an illusion. With such there can be no argument, since they place themselves outside all discussion. The Idealist is a considerably mitigated form of the last, who, however, denies the existence of an independent material world. Locke upheld the theory that we do not know things but only ideas excited in us by them. Berkeley carried this idea still further by asking how it is possible for us to know that there is anything behind these ideas to which they may be properly attributed. For, he argued, our ideas may be communicated to us by the direct action of God, without the intervention of any material objects, which, on this theory, do not exist. Thus Berkeley got rid of the material object of knowledge. Hume went a step further and got rid of the perceiving subject or soul: for he argued that whilst we do know our impressions and ideas, we cannot know anything of the mind which receives them, so that we have no right to believe in the existence of any abiding mental reality in ourselves as the subject of these ideas and

impressions. But, if that be true, then both object and subject wholly disappear and the whole universe vanishes into unreality.

It is obviously impossible to enter into any detailed discussion of these philosophical points in such a work as this: those who desire to follow it more fully must be referred to the many standard philosophical treatises which deal with it.[1] All that need here be said is that if these views are true it is waste of time to bestow any consideration on science and scientific problems.

Of course Science makes her Act of Faith and has, as most "common-sense" persons will say, abundant reason for doing so. For example, physicians all the world over administer certain drugs, and, be it remembered, administer them to patients who do not know what is being administered to them, nor the effect which it is expected to produce. Yet the effect follows, whether opium is administered in London or in New York. It is difficult to see how this can happen if there are no such things as independent realities in existence, and if all things external to us are mere illusions: this matter is more fully discussed in Chapter xxxix. It is even more difficult, perhaps, if we consider that science has been able to make predictions as to the existence of objects afterwards discovered. Adams in England and Leverrier in France simultaneously, but quite independently, asserted by mathematical calculation the existence of a planet, then unknown to astronomers but afterwards discovered and named Neptune. This feat, which is rightly considered to have been one of the most astounding performances of science, seems wholly impossible of achievement if we were confronted by nothing but illusions. "Idealism," writes Dr. Maher,[2] "is incompatible not only with vulgar prejudices, but with the best established truths of science. Astronomy, Geology, Physical Optics, and the rest of the physical sciences, are inseparably bound up with the assumption that matter which is neither a *sensation* nor an *imaginary possibility of a sensation* exists

[1] The Catholic student may be referred especially to Fr. John Rickaby's "First Principles of Knowledge" in the Stonyhurst Series.
[2] "Psychology," Stonyhurst Series, p. 113.

apart from observation. They teach that real, actual, material bodies of three dimensions, not only exist, but *act upon each other according to known laws*, whilst no human mind is contemplating them. Possibilities enjoying no existence beyond consciousness could not attract each other with a force varying inversely as the square of the distance; they could not pass from green forests into coal beds, nor could they refract or interfere with other phenomena so as to determine the character of visual sensations independently of our wills."

But though we may accept the common-sense conclusion that we must trust to everyday human experience as a safe ground for speculation and that science is justified in proceeding on the assumption that there are real bodies of three dimensions which exercise certain effects upon one another, we may still be required to answer the question as to how far it is possible to know the truth respecting the objects of our study. Pragmatism, the latest school of philosophical thought on this point—though indeed it is only a modern modification of ancient Greek ideas—would have us believe either that there is no definite truth behind our ideas, or that, if there is, it is unattainable. Truth, according to this philosophy, " is merely a quality in our ideas which 'helps us to get into satisfactory relation with the rest of our experience.' In other words, Ideas are to be tested by their practical consequences, and true ideas are those which practically will *work*. Thus there is no ultimate or final truth, or permanent reality to be known; there is for us nothing but a progressive adaptation of our ideas to one another. . . . If, as Pragmatists assert, no principle is more than a 'working hypothesis,' which may, and probably will be set aside when it has served its turn, there can obviously be no system of Ontology in which we can repose confidence; and religious and scientific convictions are both equally improbable, or can only be held under a very large measure of reserve. But the past history of human thought and enterprise does not suggest that such a system as this is likely to be at all fruitful."[1]

[1] "The Spectrum of Truth," Sharpe and Aveling. London, Sands & Co., 1908, p. 23 *seq*.

What we may conclude from this very brief discussion of a very important and very complicated matter is that Science, in the opinion of the world, is justified in regarding the objects with which she deals as realities. But we have also learnt that the whole range of knowledge and experience does not come within the scope of Science.

CHAPTER II

RELIGION: ITS SCOPE AND LIMITS

SCIENCE has her limitations, as we have just seen; so also has Religion. The Church is the mouthpiece of Revelation and Faith just as Science is the exponent of Reason and Sight; their spheres are totally different. The object of Science is to study the Universe and its phenomena; the object of Theology is to study God in the first place, and in a secondary manner the relation of His creatures to Him.

In this book we are concerned with the Catholic Church as the embodiment of Religion, and this attitude is adopted without any intended slight to the adherents of other denominations. But, as a matter of fact, the observations which are now to be made with respect to the limitations of the Church are equally applicable to all forms of Christianity.

Every Catholic is aware of the claims which his Church has upon him and what his duties towards it are. In no way, however, does it derogate from the august privileges and powers of the Church, nor in any way lower it in the estimation of any thinking person to make it quite clear that the Church has limitations in her field of work and in her teaching functions. As we shall see in a short time, there have always been—nay more, it must regretfully be admitted, there still are—the most extraordinary misconceptions as to what is meant by Papal Infallibility. I do not hesitate to say that there are still quite a number of persons who would be very much hurt if they were described otherwise than as educated persons, who seriously believe that everything said by the Pope, even down to his mere *obiter dicta*, must be accepted as revealed truth.

Of course, as every Catholic, indeed every really educated person, knows, this is foolish nonsense; but as the impres-

sion, or something closely resembling it, exists, it cannot too frequently be pointed out that Papal Infallibility is limited to the sphere of Faith and Morals, and thereby we are brought face to face with the limitations of the Church.

Science, as all its followers will admit, has no right or title to deliver judgements in matters of Religion. Nor, it may be added, has Religion any right or title to express any opinion as to the *Facts*—I desire, for reasons which will shortly appear, to emphasize the word Facts—of Science. On one occasion only has any authoritative body in connection with the Church attempted to do so. This was in the case of Galileo, shortly to be considered, and the result was not of a nature to be a source of pride to the Catholic historian.

There are wide fields of knowledge over which Religion has no sway: indeed it would hardly be too much to say that with ninety-nine per cent of the facts and theories of science Religion has no sort of concern. Religion could not inform us as to the distance between the earth and the moon, nor elucidate for us the chemical composition of the sun, the anatomy of bird or beast, nor the composition or origin of the rocks which lie around us; nor, it may be added, would any person in his senses ever seek to obtain such information from her. One does not go to a chemical laboratory for information as to the doings of Charlemagne, nor expect the professor of history to be an expert in Spectrum Analysis. The Bible, it was once said, was given to us in order to tell us how to go to heaven, not how the heavens go. So far then as concrete facts go, facts ascertainable by observation or experiment, what has often been urged is quite certainly true—namely, that Science and Religion exist in different fields and have no relation to one another, perhaps even, it would be urged by some, no points of contact. Of course this, as we shall see, is only true in a narrow and non-natural sense, but in that sense it is true. This, at any rate, is true: that Religion and Science have their respective jurisdictions in different territories and cannot, therefore, conflict with one another when rightly interpreted. In order to bring this point out I will quote the utterance of a typical man of science and that of a theologian,

and, in the latter case, I will select one not belonging to our Church. These statements will exemplify the point which I am trying to make. "Modern science," says its representative,[1] "has arrived at a systematic interpretation of the phenomena which we call 'Nature' as a vast and orderly mechanism, the working of which we can to a large extent perceive, foresee and manipulate, so as to bring about certain results and avoid others. In consequence we not only enjoy that happiness and prosperity which arises from the occurrence of the expected, the non-occurrence of the unexpected, and the determination by ourselves within ever expanding limits of what shall occur, but we also experience a delight in the knowledge of the order of Nature which comes from the exercise of our intellectual faculty and from an increased area and complexity in the sources and measure of that joy which we call 'the sense of beauty.' As to what, if anything, is outside or behind this mechanism of Nature: as to whence or how it came about, or whither it is going: as to what it and what our consciousness of it really are and why it is, and why we are here—modern science has no answer."

With this statement no theologian will quarrel; it simply implies that science of itself can give no reply to the questions stated, though this is by no means to say that from the facts elucidated by science it is not possible for the theologian to deduce many cogent arguments for the existence of an omniscient and omnipotent Creator. But the statement in question carries us a step further, for if science has no answer to these questions then undoubtedly those who speak in the name of science have no claim to assert that science has proved that there is no God, no soul, no hereafter, as at least some of those who have been described as "the camp-followers of science" may sometimes be found doing. This quite clearly follows from the statement that science has no answer to these questions.

Now let us listen to the theologian, with whose utterance I venture to think no man of science will quarrel.

[1] I take this characteristic utterance from "Science from an Easy-Chair," by Sir Ray Lankester.

Speaking of religion and science Mr. Mozley[1] says:—"The truths of these respective departments are the truths of two different spheres, which cannot come into contact with each other. If men feel a conscience within them, if they acknowledge its presages, and respect its voice as judicial, they must do so all the same under the Ptolemaic and Copernican theories of the solar system. If they derive from conscience the sense of sin they must derive it whether light is explained upon the theory of emission or the theory of undulation. There are difficulties in a personal Deity, there are difficulties attaching to prayer, and there are difficulties attaching to special providences; but those difficulties are exactly the same whether the cellular theory is true or false, and whether the sun is fed by the mechanical collision of asteroids or by the continuous condensation of its own matter. Free will is not contradicted by the uniformitarian in geology, and predestination is not contradicted by the revolutionist in geology. Scientific analysis cannot possibly discover any fresh objection to the doctrine of the Trinity, the doctrine of the Atonement, the doctrine of Grace, or the doctrine of the Sacraments."

But, if all these statements be true—and no one will deny their truth—how comes it that there is any quarrel, any ground even for dispute, between Science and Religion? That there are such discussions and even differences of opinion between the two must be patent to all men, and this is demonstrated, if by nothing else, by the fact that such a book as this should come to be written at all.

It will be well to devote some little attention to this matter, for in doing so we shall be able to clear the way for a good many considerations which will arise in later sections of this book.

There are several reasons for this difference of opinion which we will endeavour to state as clearly and as fairly as possible. Let us take the most avoidable and the least excusable first. It is certainly true that more than one scientific theory, perhaps even when in a very inchoate condition,

[1] In his "Bampton Lectures."

has been proclaimed and even exulted in as the final and death-dealing argument against Christianity. Let us hasten to add that it may be gratefully admitted that these pæans of joy seldom, if ever, come from the real luminaries of science. These, for the most part, if having no belief in religion, are content, like Sir Ray Lankester in the quotation given above, to express no opinion on the matter, in a word, to maintain that agnostic position defined and adopted by Huxley. But the assertion is often made, and made in such places as to come most prominently under the notice of "the man in the street," namely, in the pages of daily and weekly journals.

Let us take the case of Mr. Burke's so-called "radiobes."[1] People who wrote about these seemed to think that if they were what they were claimed to be—which parenthetically it may be said they were not—the whole fabric of Christianity would vanish like a dream. This is only one example of the ignorant (for we must charitably allow that it is ignorant) way in which these matters are dealt with, for if the "radiobes" had been all and more than was claimed for them, the Catholic position would be exactly what it was in the time of St. Thomas Aquinas in his controversy with Avicenna—exactly what it is at this moment—namely, that if life is spontaneously developed from non-living material it must be because the Creator infused that potentiality, under suitable opportunities, into non-living matter.[2]

This, no doubt, is a recent example, yet it may be admitted that such pæans were far more frequent during the earlier portion of the last half-century—when the wine of new discovery had a little got into the heads of some of the less exacting thinkers—than it is to-day. That time was one when "cock-sureness" rather than the scientific scepticism of to-day was the note of the hour. But, nevertheless, the thing has existed and does exist to some not wholly inconsiderable extent, and must be taken into consideration

[1] These were objects appearing in an organic fluid under the action of radium. Originally claimed to have a bearing on the origin of life, they have since been shown to have a purely chemical explanation.

[2] For a further consideration of this point see Chapter xxx.

when the question of the differences between Religion and Science are under discussion.

Some explanation of this tendency may unquestionably be found in the fact that many of these expressions of opinion are from the pens of journalists "sore gravelled for matter," and well aware that "The Final Destruction of Christianity" makes a most attractive "headline." But beyond this it is true, pitiable though it may be, that there are people who would be really gratified if it could be made quite certain that there is no God and no Hereafter. That this is not the attitude of really thoughtful agnostics is exemplified by the following quotation from the writings of the late Mr. Romanes, during his agnostic days:[1] "Forasmuch as I am far from being able to agree with those who affirm that the twilight doctrine of the new faith is a desirable substitute for the waning splendour of 'the old,' I am not ashamed to confess that with this virtual negation of God the universe to me has lost its soul of loveliness; and although from henceforth the precept 'to work while it is day' will doubtless but gain an intensified force from the terribly intensified meaning of the words that 'the night cometh when no man can work,' yet when at times I think, as think at times I must, of the appalling contrast between the hallowed glory of that creed which once was mine, and the lonely mystery of existence as now I find it—at such times I shall ever feel it impossible to avoid the sharpest pang of which my nature is susceptible."

This utterance might and probably would be made by other reverent minds unable to accept the doctrines of Christianity; but there are those others of whom the learned Fr. Wasmann is thinking when he deplores the fact that "in many scientific circles there is an absolute *theophobia*, a dread of the Creator,"[2] as to which he adds, "I can only regret this, because I believe that it is due chiefly to a defective knowledge of Christian philosophy and theology." However

[1] "A Candid Examination of Theism," 1878. It may be noted that the writer in question returned in later days to a belief in Christianity and was engaged upon a reply to his earlier work at the time of his death. This incomplete work has since been published under the title "Thoughts on Christianity."

[2] "The Problem of Evolution," London, Kegan Paul, 1909, p. 47.

this may be, there is the fact, and it has to be reckoned with, that persons suffering from theophobia and knowing the Church to be the one strong fortress of belief attack it by all means fair or foul.

Thus it often occurs that the Church and Science are made to appear out of harmony with one another by means of an illegitimate use of some scientific theory of the day: and if any exception is taken to this on the part of the Church, then "She is at her old games, trying to stifle enquiry." There is a further method very adroitly used by those who desire to discredit the Church and to represent her as the age-long enemy of science. The prescription runs somewhat in this way: Take some mediæval man of science confronted with some wholly new problem. He possesses only the knowledge (or ignorance) of his day. As almost every learned person of the time was a cleric of some kind or another, and as at any rate he is tolerably certain to have been a Catholic, it is perfectly obvious that any foolish though natural mistake which he may have made must necessarily be due to the blighting influence of Catholicity. It is as well to conceal from the public that this groper after knowledge may have stumbled upon some fact or facts in the course of his gropings which have caused his name "on fame's eternal bede-roll" to "be filed." But, if this unpleasant fact must be made known, then of course the discoveries were made in spite of the disadvantages which he suffered under from being a Catholic, and would have been much more fundamental had he not been in terror of what the Inquisition might do to him. By this means it is possible to picture a very pretty quarrel between Religion and Science.

Perhaps it may not be amiss to give an instance of what has just been alluded to. When fossils first came under the observation of thinking men it is not wonderful that they should have excited great curiosity and even greater wonderment as to their nature and origin. Amongst those men of science who tried to account for them was one Gabriel Fallopius, a canon of Modena, who thought, foolishly enough as we now know, that they were "generated by fermentation in the spots where they were found"; or that they had in some cases acquired their

form from "the tumultuous movements of terrestrial exhalations." The remarks are inept enough, as all will admit, but can it be credited that it has actually been claimed that these assertions were made by a dignitary of the Church—who we must suppose knew what the real explanation was—for no other purpose than that of deceiving the unlearned in the interest of his Church!

It does not seem to have occurred to such persons, nor would they probably allow such a thought to occur to them, that Fallopius made a very foolish mistake quite explicable in one whose date was 1523–1562. Others, with much less excuse, have also made foolish mistakes without thereby forfeiting the name of scientific authorities. Huxley admittedly fell into a very gross error over his so-called "Bathybius Haeckelii"; yet I have never seen the accusation hurled at his head that he declared an inorganic object to be organic in order to persuade his unlearned audience that it explained the origin of life. No doubt Fallopius's statements with regard to "tumultuous movements" are vague, but vagueness was a not unnatural feature of the time. Is their vagueness after all any greater than the vagueness of Herbert Spencer's statement that "inorganic matter, through successive complications, gave origin to organic matter"? "Successive complications" and "tumultuous movements" make a very pretty pair of nebulous remarks, and there is certainly not less excuse for Fallopius than there is for Spencer. To complete the tale, two further points are carefully concealed from the reader. The first of these is that Fallopius was the discoverer of certain important things in the science of Anatomy to which his name is attached—a tube and an aqueduct (so called)—so that he was not quite the nonentity that he might be imagined to be. Further, it is still more carefully kept in the background that the first man to set science on the track of the truth respecting fossils, was also a Catholic churchman, and what is more a bishop—also by the way a distinguished anatomist—whose name is connected with important discoveries in that subject, but whose greatest scientific fame it is that he is acclaimed to be the Father of Modern Geology by all the authorities in that subject. This

was Nicolaus Stensen, whose life extends from 1638–1687.[1] Of course it is quite clear that when a churchman makes a foolish blunder it is the Church which is responsible, indeed he probably made it to bolster up the pretensions of that organisation. But when the same man makes a valuable discovery, the Church not only has nothing to do with it—which is probably quite true—but would have harried him to death if it could, for having made it. When Dr. Johnson was asked why he had made a mistake in the definition of some part of the anatomy of a horse in his Dictionary, his reply was "Crass ignorance." Crass ignorance, misrepresentation—it is to be feared at times purposeful misrepresentation—are amongst the causes of the disputes, real or apparent, between Religion and Science.

Finally, in strict fairness, it must be said that the defenders of Religion are not free from responsibility. In this matter, indeed, Religion more than once has been in a position in which she might well have asked to be delivered from her friends. What is here being alluded to is the often foolish way in which quite incapable representatives—self-chosen too—of Religion have often made fatal havoc of their case by failing to understand their opponent's position, or the real effect which his theory might have upon religious dogmas and by endeavouring to confute what they supposed to be the point at issue by arguments often of an inconclusive character and frequently not even *ad rem.* This is no more than to say that all defenders of religion are not infallible, and the same might be said about writers on science. At any rate there is no doubt that the Church gets full credit for this kind of defender.

Then, of course, there is the case of Galileo, which never fails to be cited when this matter of the Church and Science comes under discussion. This is assumed to have been only the most prominent instance of a habitual line of conduct instead of actually being the only case of the kind on record. It may seem superfluous to say anything more on this point, but, as several important questions closely connected with

[1] An account of his life will be found in the book "Twelve Catholic Men of Science," published by the Catholic Truth Society (1s. 6d. net). See also the account of his work in the "Encyclopædia Britannica," *sub voce* Geology.

our subject are involved, it may be permissible to devote a brief space to a survey of this matter.

NOTE.—The following passage from a paper by that distinguished geologist and Catholic A. de Lapparent[1] ("Revue pratique d'apologétique," 1906, pp. 270–1) shows clearly his experience of the attitude of the Church to-day towards science. "In spite of the care which I had taken to keep myself exclusively on scientific ground, it happened to me once or twice to be severely taken to task by the sharpshooters of apologetics, displeased at not finding in my publications any argument in favour of particular theses which they had constructed. But these episodes (which indeed made little commotion) had the result of displaying the extreme wisdom of the authorities whom they were attempting to rouse. These supreme judges were not disturbed. So far they have seen nothing incorrect in the enunciation (which of course is subject to ulterior rectification) of theories in which one is satisfied with summarising the facts which seem established by observation. I feel bound to state that no one ever felt so free in speech and writings as I myself have done. Rarely indeed has a professor received more explicit and continual assurances of a goodwill all the more valued as it came from high quarters. Without claiming to find herein any dogmatic confirmation of the views exposed in books of science, I see in it at least a motive for rendering a special homage to the wisdom of the Church as well as to her consideration for sincere opinions which are submitted in advance to her definitive jurisdiction."

[1] For an account of his life and writings see "Twelve Catholic Men of Science," referred to on opposite page.

CHAPTER III

THE RELATION OF THE CHURCH AND POPES TO SCIENCE: GALILEO

THIS chapter is perhaps somewhat in the nature of a parenthesis, but in the writer's opinion it is a necessary parenthesis. It cannot be expected that the general reader should be intimately familiar with the attitude of the world towards learning and new discovery in the Middle Ages, nor can such a reader be expected to make himself acquainted with the real facts concerning the attitude of the Church, and especially of the Popes, towards Science. Wherever he finds any allusion to such points in the writings of non-Catholic authors, even when unbiased against the Church, he will hardly fail to run up against the oft-repeated statement that the Church is the deadly enemy of all science, and that, if she only had the power, she would once and for all put an end to all learning and all research into Nature. He reads statements such as these and he comes to the conclusion—he could hardly perhaps do otherwise—that the Church really is the enemy of progress. If he is a good Catholic he probably makes an Act of Faith, gives a sigh, and goes his way a little discouraged as to the body to which he belongs. It may perhaps cross his mind that he has heard, and correctly too, that nearly every one of the more important and ancient Universities owes its origin to the Bull of some Pope, and that may give him pause for a moment. Still the spirit of distrust has been roused in him—all the more certainly if he has found the depreciatory statements, as he may quite well do, in a book written by a man whom he knows to be but little influenced by anti-religious prejudice.

It is largely in the interests of persons of this kind that

this parenthetic chapter is introduced, and if it does nothing else than inform them that in the erudite works of Dr. J. J. Walsh of New York they can find a complete answer to all these misstatements, it will at least have achieved the purpose of making it plain that there is an answer, and a very sufficient answer too, to all these misrepresentations of the attitude of the Church towards learning of all kinds, and especially towards that kind of learning which is known as Science.[1] How have these misrepresentations come to exist ?

We may leave aside those baser persons who have deliberately invented accusations of intolerance : there have been such, and with them there is no way of dealing except by showing the utter falsity of their statements. But there are others, blameworthy though less blameworthy, who have been content to take their facts secondhand from writers who do not seem to have taken any particular trouble to verify the statements to which they have committed themselves.[2]

Let us take one instance of a hoary fable which has from generation to generation served as an example of the obscurantist policy of the Popes ; I refer to the oft-repeated statement that the dissection of human bodies was for-

[1] " The Popes and Science " is the first of Dr. Walsh's works which the reader should apply himself to, and, having done so, he will not require any persuasion to continue his reading of the remainder of the series. With respect to Galileo, the reader is advised to consult the late Fr. J. Gerard's penny pamphlet if he desires a very brief statement of the matter. If he wishes for fuller information, he will find it in the admirable account, with full copies of all the documents in connection with the matter, written by Fr. Ernest R. Hull, S.J., from which most of the facts and quotations in this chapter are taken. As will be gathered from those quotations, neither of the above-named writers is desirous of blinking the unpleasant facts connected with the case under discussion. All of these books are published by the Catholic Truth Society, which also publishes a volume, " Twelve Catholic Men of Science," edited by the writer of these pages, in which a good many answers may be found to the allegations complained of in this and the previous chapter.

[2] I might call attention to a recent work by a really distinguished geologist, Canon Bonney—" The Present Relations of Science and Religion," London, Robert Scott, 1913—in which almost the whole of the chapter on the Catholic Church is based on White's " Warfare of Science," which has been so frequently refuted and by none more successfully than by Dr. Walsh. Bonney's accuracy may be judged from the fact that he states that Newman's " Essay on Development " was " written to justify his secession to the Roman Communion ! "

bidden, and consequently all progress in Medicine and Surgery put an end to, by the dictates of Rome. Now supposing this to have been true, it might have been charitable to look upon it as an unfortunate but perhaps excusable concession to the weaknesses of those unreasonable but very real persons who even to-day make the task of the human anatomist so difficult, and must have existed with tenfold force in the Middle Ages—the objectors to human dissection. Leaving that consideration on one side, the anatomist who meets with this statement is surely bound to look upon it with doubt if he knows anything about the history of his subject, the nomenclature of which is full of the names of Italian anatomists of the Middle Ages as, for example, Fallopius and Stensen, mentioned in the last chapter, or again as Eustachius and others who actually practised this alleged-to-be altogether forbidden art in Rome under the very nose of the Pope, whose body-surgeons they often were, and further had the audacity to publish their discoveries in Rome and lay them at the feet of the reigning Pontiff. Of course there is one explanation of this and only one possible explanation: there was no such edict against dissection. Was there anything which might have been so construed? I must confess that when I was teaching Anatomy and came, as I often did, across this story, I set it aside as the usual anti-Catholic lie, for of course I was well aware of the numerous papal anatomists and of their work. But the indefatigable Dr. Walsh went further, for he took the trouble to burrow into the records until he got to the bottom of the matter. And what is the explanation of the story? Well, it appears that during the Crusades many of the warriors left directions that if they lost their lives when away from home, their bodies were to be brought back to their native places for burial. It is perhaps unnecessary to point out in any detail how difficult if not impossible a task this imposed upon the survivors. In order to lighten it they adopted the barbarous but practical expedient of dismembering the dead bodies, boiling the flesh from off the bones and bringing these more portable portions of the body home for interment. This was what the Popes forbade under pain of excommunication—

whether wisely or foolishly matters nothing to the present argument. That the prohibition has nothing to do with the practice of ordinary dissection is perfectly clear.[1]

Then again there is the individual only too common, who has neither knowledge nor imagination enough to place himself in the position of one living in the Middle Ages and to try to think how he, under those circumstances, would have confronted any new discovery which was brought under his notice. Yet in this is to be found practically the whole explanation of the so-called opposition of the Church to Science. The whole spirit of the age was necessarily doubtful of any new thing, and the Church which existed in that age had many of the prejudices of its period. Being composed of the men of the age, how could it well be otherwise? Let us look at the matter for a few moments from this point of view.

First of all we have to remember that, unlike our own time—when everybody expects to find a new discovery each day in his morning's paper, and when everybody's mind is consequently in tune for new facts—the attitude of the Middle Ages was to imagine that the last word had been said on all matters of knowledge, usually by Aristotle, and to look, therefore, on all new facts as superfluous, if not annoying. Doubtless a foolish attitude, but there it was. Further, we can hardly imagine the extent of the obsession of people's minds with regard to Aristotle and his authority. As an example of this the following may be given:[2]

A Jesuit Father, Scheiner, who appears to have made the discovery of sun-spots independently of Galileo, submitted this discovery to his Provincial, whose response was as follows: "I have read Aristotle's writings from end to end many times, and I can assure you that I have nowhere found anything similar to what you describe. Go, my son, tranquillize yourself. Be assured that what you take for spots on the sun are the faults of your glasses, or your

[1] The reader will find the matter fully discussed and copies of all the documents in question in "The Popes and Science," Catholic Truth Society, 1911, p. 28 *seq.*

[2] The incident is narrated by Fahie, "Galileo, His Life and Work," Murray, London, 1903, and quoted by Hull.

eyes." Scheiner was allowed to publish his observations, but anonymously.[1]

The average writer would set all this foolishness down to the obscurantist policy of the Church, not to speak of the well-known and double-dyed obscurantism of the Jesuits whom everybody knows to maintain observatories and laboratories for no other purpose than of frustrating the progress of science. But, as a matter of fact, it was nothing of the kind. It was the obsession of Aristotle—never yet acclaimed as a Doctor of the Church—and of Aristotle, not only as the philosopher but also as the scientist, from whom the excellent Provincial and nearly all the men of his age suffered.

Mr. Hinks[2] points out as a curious fact that "while many of the principal facts, the rotundity of the earth, the gradual change in the position of the pole among the stars, were known to the famous astronomers of antiquity, who were Greeks, yet the influence of the Greek philosopher Aristotle was for many centuries sufficient to stifle any spirit of enquiry into the truths of astronomy. That their teaching was contrary to Aristotle was enough to condemn Copernicus or Galileo. . . . The first astronomers of Europe had to work against, not with the support of, whatever remained in repute of the ancient learning of Greece. At every turn they were stopped with the objection that Aristotle said so and so. Now what Aristotle said was founded upon the

[1] I give this tale, with the respectable authority for it, as an example of what is said of the extreme Aristotelomania of the time, as to which, it may be added, much more of the obloquy belongs to the anti-Scholastic Averroists and Alexandrians of Padua and Venice than to the much-abused Scholastics themselves. Perhaps the more correct version of the Scheiner story is this: He observed sun-spots in 1611, using a helioscope which he had either invented or perfected. His Provincial (one Busée) counselled prudence in publication. So he published anonymously in 1612 his "Tres Epistolæ de Maculis Solaribus" and his "De Maculis Solaribus et Stellis Ursina" (the printing of which was begun in 1626). In this he tells us (*lib.* i, c. 2): "My Superiors thought that I should proceed slowly and cautiously until the phenomenon should be corroborated by other people's observations, and that I should not depart from the beaten track of the philosophers without evidence to the contrary," which seems very sensible advice and much more probable than the tale in the text. As another instance of the Aristotelomania of the day may be quoted the tale which relates that Cæsar Cremonini (1552–1631) refused to look through Galileo's telescope for fear of finding that Aristotle's physics were wrong!

[2] "Astronomy," in Home University Library, Williams & Norgate, n. d., p. 9.

vaguest kind of foundation. Planets must move in circles because the circle is the only 'perfect' figure. Seven is a perfect number, and therefore if you have found seven of a thing you need not waste time looking for an eighth. This was the kind of argument that passed for scientific in the Middle Ages; this was the kind of prejudice which the early European astronomers had to rid their own minds of first, and then to banish from the minds of others."

Very foolish, no doubt; still it was the spirit of the period, and unless we try to grasp that fact it is impossible to understand the relations between religion in general and science at that time. Again, the very idea of proving a statement by experiment never seems to have entered into the minds of men; "if it is in print, it must be true" seems to have been their attitude. Take, for example, the case of the discussion between Galileo and Sarsi.[1]

Sarsi quoted Suidas, in support of his theory that motion always produces heat, to the effect that the Babylonians used to cook their eggs by whirling them in a sling. Galileo replies by pointing out that it is quite easy to repeat the experiment and by so doing to expose the absurdity of the statement. Sarsi, no doubt, had never thought of that; an excellent illustration of the attitude of the time which has to be reckoned with. "Yes," it will perhaps be argued, "but all these instances relate to places and persons under papal sway, and it is just that baneful influence which led them to take up these absurd positions." Well, Francis Bacon was pretty nearly contemporary with Galileo. No one will contend that *he* was under papal sway, nor has he ever been charged with being an obscurantist: in fact he is often called the Father of Modern Science. Yet Bacon's writings are full of the same kind of errors which might easily have been corrected by experiment. For example,[2] wooden arrows without an iron point penetrate farther into wooden substance than the same arrows pointed with iron, owing to "the similitude of substance." No more foolish sentence could be discovered in Sarsi.

[1] "Galileo," by Hull, p. 40.

[2] "Natural History," Cent. viii, 704. A number of similar absurdities can be culled from his pages.

Again in 1596—that is, some thirty odd years before Galileo's trouble—the University of Tübingen was certainly not under papal sway or influence: its Theological Faculty was of a purely Protestant character. Yet that Faculty censured Kepler most unmercifully for writing a book in favour of the Copernican views—that is, for taking up the same position as Galileo was to take up somewhat later. In fact they harried the unfortunate man to that extent that he fled from Tübingen, and to whom? Of all people in the world, to those notorious obscurantists the Jesuits of Gratz and of Ingoldstadt, who welcomed him warmly on account of his great services to learning! Still two wrongs do not make a right, and the Protestant condemnation of Kepler does not make the Catholic condemnation of Galileo any the more tolerable.[1]

But it does help us to understand how it came about. And, further, it does lead us to ask ourselves how it comes about that whilst we are dosed with the Galileo episode *ad nauseam*, we never hear Protestantism attacked for its treatment of Kepler. At any rate, what has just been said will help us to understand to some slight extent the kind of world into which Galileo was born. Galileo (1564–1642) found himself confronted by two theories as to our solar system. There was the geocentric theory of Ptolemy, which made the earth the centre around which the sun, moon, and stars revolved; and there was the heliocentric theory of Copernicus, which regarded the sun as the centre around which the earth and the other bodies in question revolved. Galileo's observations led him to adopt the latter theory, which everybody now knows to have been the correct one: but it was the unpopular view amongst the men of science of the day, not to speak of the theologians of various kinds. They attacked Galileo and his theory on scientific grounds, and, being worsted, turned their attention to the religious

[1] As bearing upon the history of the time and its ideas, it must not be forgotten that Servetus, in whose "Christianismi Restitutio" (1553) occurs the first description of the pulmonary circulation ever penned, was slowly and barbarously roasted to death at Geneva by order of Calvin. Cardinal de Tournon, who controlled the Inquisition in France, had previously rejected with scorn the accusation of heresy which the arch-heretic Calvin had sent to him against Servetus.

aspect of the case. Literal explanation of every proposition in argument had been fostered by the scholastic method of discussion. Further, the controversies with the Protestant Reformers, committed by their fundamental principles to theories of rigid verbal inspiration, had intensified this narrow method of scriptural exegesis, and caused the ancient broad figurative and symbolic interpretation of S. Augustine and other Fathers to be at times lost sight of, even by theologians when drawn into ardent controversy on properly scientific questions, unfortunately with subsequent discredit to the cause of religion. In a later chapter our present attitude to this question will be alluded to—a question adequately and illuminatively dealt with by Leo XIII in his Encyclical " Providentissimus Deus."

It was on account of its apparent inconsistence with the Biblical account of the miracle of Joshua and the sun that the Theological Faculty at Tübingen had condemned Kepler, and it was on very similar grounds that the Qualifiers or experts of the Holy Office or Inquisition gave their celebrated verdict that : " the proposition that the sun is the centre of the world and does not move from its place is absurd and false philosophically, and formally heretical, because it is expressly contrary to Holy Scripture " : and (2), " The proposition that the earth is not the centre of the world and immovable, but that it moves, and also with a diurnal motion, is equally absurd, false philosophically, and, theologically considered, at least erroneous in faith."

In thus concluding, the experts did take upon themselves to condemn what we all now believe to be a fact of science. Of course, at the moment it was a theory only, but let that pass. In this, as all writers now agree, they acted wrongly and foolishly, and led the Pope, who possibly did not know very much about what was under consideration, into error with them. No doubt Galileo's own conduct,[1] which was

[1] Of course what was really wrong with Galileo was that he was unable to grasp the conception of a " working hypothesis," a thing well known and well recognised to-day by men of science, though apparently unknown to many of the writers on " popular science." In his " Trattato della Sfera," written in 1606, Galileo adopted the Ptolemaic views as not merely useful but as indisputably true. Later on he was equally sure of Copernicanism, though his proofs were patently inadequate, and one of them, that based on the tides, wholly wrong.

tactless and provocative in the extreme, conduced to a condemnation which might otherwise not have been asked for, perhaps even obtained. But none of this really excuses what took place, and in the interest of truth the fact should not be blinked. Huxley, who certainly was not biased in favour of the Church, stated his opinion as follows: "I looked into the matter when I was in Italy, and I arrived at the conclusion that the Pope and the College of Cardinals had rather the best of it."[1] That Catholic writers take a less favourable view than did Huxley may be gathered from the following quotations: "In spite of such pleas" (i.e. pleas, Catholic and Protestant, on behalf of the Roman authorities), "we can only deplore the prosecution of Galileo, and the assumption by an ecclesiastical tribunal of authority to which it had no claim in the domain of physical science."[2] "The official documents plainly embody the view that the Copernican theory was not only 'false' but also 'heretical' because 'altogether contrary to Scripture'; and Galileo was condemned as 'grievously suspected of heresy,' which heresy is defined as 'holding that the earth moved and the sun stood still.' It is precisely in this dogmatical pronouncement on the heretical character of the new astronomy that their blunder consisted."[3] It has been claimed by some who were wholly ignorant of what they were writing about, that the Infallibility of the Church and of the Pope was involved in this decision. It would be impossible here to deal fully with the matter, so we content ourselves with summing up the reply in the words of a very distinguished Protestant astronomer:[4] "The Catholic doctrine on the subject" (Papal Infallibility) "is perfectly definite; and it is absolutely certain that the decision in regard to Galileo's teaching, shown now to have been unsound, does not in the slightest degree affect the doctrine of infallibility, either of the Pope or of the Church. The decision was neither *ex cathedra* nor addressed to the whole Church; in not one single point does the case illus-

[1] "Life and Letters," Macmillan, London, 1900, II, 113.
[2] Gerard, *op. cit.*
[3] Hull, *op. cit.*, p. 118.
[4] Proctor, in "Knowledge," Vol. IX, p. 274, teste Hull, p. 117.

trate this doctrine of papal infallibility as defined by the Vatican Council."

Lastly, we may look at the further history of the question, which, as Cardinal Newman somewhere points out, is remarkable above all things for this fact that it is the only case of its kind which the enemies of the Church are able to bring against her.

Father Hull sums the matter up thus: "In spite of its condemnation by the Roman Congregations, the Copernican doctrine gradually spread till it was finally clinched by Newton's *Principia* in 1696, and so secured general acceptance. The decrees of the Congregations were by no means regarded as having closed the question for Catholics; and, generally, no scruple was felt on disciplinary grounds as regards professedly teaching the new theory in Catholic colleges. Thus, as early as 1634, leave was given to introduce instruments for the teaching of astronomy in Rome based entirely on the Copernican system. Cardinal Barberini, nephew of Urban VIII, was presented with one of them. In 1639 and 1645 Bulialdus and Gassendi, both of them Catholic priests, undertook the defence of the Copernican system, and were neither reprimanded for it nor suspected of heretical teaching.

"In 1656 the *Imprimatur* was given in Rome itself for a defence of Copernicus against various physical and astronomical objections; and the same occurred again in 1667 and 1669. In 1661, P. Fabri, S.J., professor at the Roman College, publicly declared that the authorities would at once adopt the figurative explanation of the various passages in Holy Writ, if only a real proof for the Copernican system were forthcoming. P. Baldigiani, S.J., in 1678, thought that the time had come to revoke the decree forbidding the reading of the *Dialogues*; and in 1685 P. Kochansky went so far as to state that every Catholic was allowed to search for a proof of the truth of Copernicanism. Meantime [like the ancient obsolete laws in England], the decrees remained on the books, and presented a certain technical difficulty to the canonist. Hence, in 1757, Benedict XIV expunged the universal prohibition of 1640. In 1744, Galileo's *Dialogo* was allowed to be included in a new edition of his

collected works. In the year 1820 positive official permission was asked for and granted by Pius VII to Canon Joseph Settle, a Roman professor, to publish a textbook on science, containing the Copernican doctrine. Finally, in 1822, the Inquisitor-General, under the sanction of Pope Leo XII, declared that the printing and publication of works treating of the motion of the earth and the stability of the sun, according to the opinion of modern astronomers, is permitted in Rome. In the next edition of the Index, dated 1835, the decree of 1616 and all others touching the question, as well as the names of all the prohibited books, were finally expunged from the list." [1]

The criticism which at once rises to the mind is that it took a long time to convince Rome that a mistake had been made. In this connection it is only right to remember that the mistake was admitted eventually by the highest authorities, and that it is at least fair to argue that, having once fallen into error, it was better to wait and make perfectly certain before once more expressing an opinion. But this point may be raised again in a subsequent chapter.

[1] It may be interesting to note that the famous expression attributed to Galileo after his disavowal of the earth's motion (*e pur si muove*, i.e. yet it does move), which has unfortunately been adopted as a motto for that very useful series the Home University Library, is a myth. The earliest known source of it appears to be the Abbé Irailh's "Querelles Littéraires," Paris, 1761. (See "Notes and Queries," 7th series, xi, 424.)

CHAPTER IV

PHILOSOPHY

IN the course of the preliminary pages of this book, when the subjects which were to come under discussion were being enumerated, mention was made of a third factor in addition to Religion and Science—namely, Philosophy: and to that subject it will now be necessary to devote some attention. More especially it will be necessary to draw attention to and to correct certain wholly inaccurate ideas which exist in the minds of many persons with regard to that system of Philosophy which is usually known by the name of Scholastic. The term Philosophy, like the term Science, has come to possess a much narrower significance than it once had, or indeed than its derivation warrants.

Philosophy means a love of knowledge, and it must be admitted that, if such were its present-day signification, a considerable number of persons would be entitled to describe themselves as philosophers to whom the world would deny that title, at least in its rigid significance.

At the present day philosophy means a system of unification and explanation of knowledge, or of the sum of knowledge.

The learned Professor de Wulf says that "all philosophy consists in a rational study of all or some of the problems arising from our attempts to explain the universal order of things by their ultimate causes or principles."[1] It will scarcely be necessary to remind the readers of this work that whilst the term Philosophy is one, the systems of Philosophy are many, and are usually distinguished from one another

[1] "Scholastic Philosophy," Dublin, Gill, 1907, trans., Coffey, 1907, p. 7. Quotations from this work in this or subsequent chapters will be cited as de Wulf.

by the names of their founders; thus there are Kantians, Hegelians, and so on.

The Scholastic system or system of the School is the system traditionally associated with Catholic teaching institutions, and it is that with which we shall chiefly be concerned in this book. It must, therefore, be very briefly dealt with, and its exact relationship to the Church explained.

The Scholastic Philosophy may generally be said to be built upon the works and ideas of Aristotle, who, though he was affected by the erroneous science of the day, was undoubtedly one of the greatest thinkers and most powerful intellects in the history of the world. The system was developed by many great writers, not always by any means on identical lines. For an account of these we must refer our readers to some general work on the History of Philosophy.[1] Here it need only be said that the exponent whose name is of the greatest significance to us is St. Thomas Aquinas (1226–1274), a man whose marvellous knowledge and extraordinary output of work during the comparatively few years of his life upon earth cannot but excite the astonishment of all who devote even the most casual attention to the subject. From him is named the Thomistic Philosophy, which is a form of Scholastic Philosophy, and that form which has received the special approbation of Pope Leo XIII, in his celebrated Encyclical "Æterni Patris."

From the very fact of its close connection with the Church and her teaching organisations, there have arisen two misconceptions altogether too prevalent, even to-day, to which attention must be drawn. First of all, it is a common mistake to confuse Scholastic Theology with Scholastic Philosophy; and secondly, even if this mistake be not made, to imagine that the scholastic philosopher is so tied and bound by authority that he cannot deal freely and independently with his subject. On these two points I shall not rely on my own statements, which would be of but little value, but shall quote freely from those whose

[1] The general reader may be confidently recommended to read de Wulf, as translated by Coffey. Admirably translated and not unduly technical, this book gives an adequate idea of the older and of the newer Scholastic Philosophy. It is published by Gill in Dublin and by Benziger in America.

expressions of opinion must be listened to with respect as coming from acknowledged authorities on the subject. There is perhaps some excuse for the first mistake, for there is a Scholastic Theology as well as a Scholastic Philosophy, and, at least during the Middle Ages, the authors of books upon one of the subjects were often, if not usually, also the writers whose names are known in connection with the other; such, for example, was the case with St. Thomas Aquinas.

But that does not make the two subjects identical, and de Wulf[1] bids us beware lest we confound, "as happens too often, *scholastic philosophy* with *scholastic theology*. Theology is not a study of the universal order by the light of human intelligence; it is, at least in its dogmatic portion, a systematisation of certain doctrines that a positive revelation has delivered to us. To confound scholastic philosophy with scholastic theology is to confound the examination of natural truths by reason with the study of Christian dogma —as if scholasticism were only, as Brucker expresses it, a discussion of revealed mysteries by the light of the badly understood principles of Aristotelianism." In a further passage de Wulf strenuously opposes this false view, pointing out that, if it were true, the history of mediæval philosophy would be nothing more than a subsection of the history of religions. And he continues, "What determines the proper individuality of each of the various sciences, what furnishes us with a test of their diversity, is not, the scholastics tell us, the identity or diversity of the materials which they treat (the material object of the sciences), but the treatment itself of those materials (formal object of the sciences). The distinction between two sciences is altogether due to the distinction between the *points of view* from which they regard things, of their principles and of their methods of procedure. Just as two architects can build, by different arrangements of the same stones, the one a Roman temple the other a Gothic cathedral, so can two sciences deal with the same realities, provided they approach them from different standpoints. The astronomer, remarks St. Thomas, studies the rotundity of the earth, no less than the physician,[2]

[1] *Op. cit.*, p. 8.
[2] The physicist, not the medical man, is here meant.

but the former draws his proofs from mathematics, the latter from the laws of matter. So it is with theology and philosophy. Each presents under every respect the characteristics of that independence which is proper to a distinct science. The one is based on the revealed word, the other on the light of reason: the one is built up by way of authority, the other proceeds by scientific proofs. Thomas of Aquin, Henry of Ghent, Bonaventure, Godfrey of Fontaines, Duns Scotus—in a word, *all* the scholastics, have given expression to the same view regarding *the distinction between theological science and philosophical science.*" The other error is that, though Scholastic Philosophy and Scholastic Theology may be formally recognised as being distinct studies, yet the former is so much based upon and conditioned by the latter as to be unworthy of the name of an independent branch of study. This objection was actually pressed before the Irish Privy Council quite recently in connection with the opposition to an appointment of a lecturer in this subject in a college in Ireland. It was then contended that the Scholastic system was not really a philosophy at all "inasmuch as it was avowedly based on the authority of the Roman Catholic Church, and accepted this authority instead of the evidence of reason as the ultimate motive of assent to all its teachings."[1]

Now to this error also de Wulf calls attention, remarking "what a number of modern authors fall into the same error and think that 'the content of the ideas being fixed by dogma, no liberty remained except in the method of explaining and applying them.' If scholasticism be no more than that, we may truly call it no longer a *philosophy*, but an exegesis of belief, a commentary on the faith, a mere plea *pro domo.*" But I shall allow Dr. Coffey to speak on this matter. "Anyone," he writes, "who has even a superficial acquaintance with scholastic philosophy will be aware of its clear and emphatic insistence on the fact that no *authority*, human or divine, can be the *ultimate* 'test' or

[1] Coffey, quoting from the report of the proceedings before the Privy Council in his article "Philosophy and Sectarianism," "The Irish Theological Quarterly," October, 1910. The learned Professor of Philosophy at Maynooth is admittedly an unexceptionable authority on his subject, and I quote his criticism of the opinion in question a few lines lower down.

'criterion' of truth, or the last underlying ground for our assent to, and acceptance of, any truth; and this for the very simple reason that whenever we do assent to truth on authority, we must first have employed our own *reason* to estimate and judge the *evidence* forthcoming on behalf of the knowledge and truthfulness of that authority. This is a dictate of common sense; and it is applied by scholastic philosophy to *all* authority—including the authority of God and the authority of the Church (and the Bible) in regard to the contents of the Christian Revelation. Were we unable to convince ourselves on grounds of reason—namely, by submitting to the independent judgement of our own reason the *objective evidence* available—that an all-wise and all-truthful God exists and has spoken to men, and that His revelation is faithfully conveyed (in the Bible, or in the Bible and Tradition) and accurately interpreted for us by the Church (or by ourselves, according to non-Catholic Christians) we could not *rationally* assent (whether as Christians or as men) to what the Church (or the Bible) proposes to us for our belief.[1] So scholastic philosophy teaches that *objective evidence*, estimated by the careful and cautious use of our own judging and reasoning faculties, is the *ultimate* test of all truth. And if it taught otherwise it would obviously stultify both itself and whatever authority, whether human or divine, it purposed to examine. When, therefore, truths are proposed for our acceptance by authority, scholastic philosophy teaches that before believing them we must convince ourselves by our own individual reason that the authority is trustworthy. And when there is question, not of truths to be believed on authority, but of such truths as can be tested and verified by examining the intrinsic evidence for them in the light of our own reason—for such truths it teaches that human authority is the *weakest of all motives of assent*. Aquinas himself, the prince of scholastics, has laid down this principle in unambiguous terms—'*locus ab auctoritate quae fundatur super ratione humana est in-*

[1] The Catholic reader will remember that the necessity of supernatural grace for the making of an act of faith leaves such act still conditioned by the laws of *rational* assent.

firmissimus.' How absurd it is, then, to represent scholastic philosophy as teaching that the ultimate criterion of truth is 'Revelation as interpreted by the Church.'"[1] The Scholastic Philosophy is a method of dealing with facts. Whether it is the best method or not is a question on which general agreement has never been reached and probably never will be reached. It is the traditional method of the Catholic world, no doubt; but that is not to say that the Catholic Church stands or falls by it.

This at least may be said, that all its instructed opponents allow that the scholastic is a distinct, clear-cut, complete method of Philosophy, a method, moreover, capable of application, as any true system of philosophy must needs be, to every new discovery which may be made in any branch of learning.

A remarkable fact, which will appear in later sections of this book, is that in certain cases ancient thinkers seem to have arrived at the same conclusions as modern science though by very different roads—the one by that of pure thought, the other by the slow and painful but, to most of us at any rate, more convincing path of observation and experiment. If eventually the fact emerges that pure reason can untie and has untied a knot long before science has accomplished that task, it at least permits us to look not with less respect on the work of science but with more upon the cogitations of the philosophers. This is not a manual of philosophy, nor has the author of this book any title to speak for philosophers, but it seemed necessary, in view of the many misconceptions and misunderstandings which have been woven around the subject, to make these few observations; to which this may be added for the sake of those readers, if any, who are wholly unfamiliar with the Scholastic Philosophy and its value. Catholic Philosophy, by which is meant the Scholastic Philosophy, has been belittled and sneered at usually by those very imperfectly acquainted with its scope and work; and the general and uninstructed reader is led to conceive that as a subject of real importance it has long ago disappeared, behind a cloud of unextinguishable laughter, from the consideration of

[1] "Philosophy and Sectarianism," pp. 9, 10.

really scientific minds. "What is to be said," it is asked, "of a philosophy which concerns itself with such trifles as the question of how many angels could dance on the end of a needle?" "What is to be said," we might reply, "of a subject like Mathematics, which concerns itself with such a thing as the Fourth Dimension, as to the very existence of which we have no knowledge, a thing, moreover, which, if it did exist, would turn everything we know to confusion and chaos?" The fact is that all great sciences, like Mathematics and Philosophy, must have their explorers into remote and undiscovered districts which appear to be grotesque and fantastic to the ignorant or half-informed. The Fourth Dimension is a fascinating and most scientific subject to those who are capable of understanding it, and the philosophic problem mentioned above is not a mere joke but an abstract example of the vast philosophical subject of the relations between matter and spirit, the extended and the unextended.

With all this, however, no historian can deny, nor do Catholics attempt to do so, that an epoch arrived when Scholasticism fell into a state of serious decadence. "There were vexatious and inexcusable faults of method; the endless multiplication of distinctions and sub-distinctions and divisions and classifications, on the plea of clearness; until finally all thought became mystified and muddled in an inextricable maze of scheme, systems, and departments! Nothing could have been better calculated to foment those abuses than the dialectic formalism that poisoned all the philosophical writings of the sixteenth century."[1] The same learned author may with advantage be quoted on another all-important point, namely, the disregard of new scientific discoveries which marked the hide-bound philosophers of the period of the decadence; their fatal obsession by Aristotle in his worst as well as in his best moments, to which allusion was made in the last chapter. All these things explain why the new learning, disgusted at the attitude taken up by the scholastics of the day, clamoured for the complete abolition of the system which they so much misunderstood since it had been so much abused. "No-

[1] De Wulf, 147.

where," he writes,[1] "was the culpable ignorance of the scholastics regarding contemporary thought so disastrous as in the domain of the natural sciences. Great discoveries were everywhere revolutionising physical and mechanical astronomy, physics, chemistry and biology, and the mathematical sciences as well. The geocentric system of Ptolemy gave place to the heliocentric system of Copernicus; and Galileo's telescope had begun to reveal the secrets of the heavens. But the paths of the stars careering through the immensities of space gave the theory of solid celestial spheres its death blow; the displacement of the sun-spots on the solar disc revealed a rotatory movement in the sun itself; the moon displayed its mountains and plains, Jupiter its satellites, Venus its phases, Saturn its ring. In 1604, a hitherto unknown star was discovered in the sign of the Scorpion. Later on it was shown to evidence that the magnificent comet of 1618 was not an atmospheric will-o'-the-wisp but a heavenly body moving through the interplanetary regions of space. Then Kepler formulated the laws of the elliptical motion of the planets, and Newton inferred from Kepler's laws the law of universal gravitation which unified all astronomical phenomena. In another department, Torricelli invented the barometer and discovered the weight of the air; heat and cold were registered by the thermometer not as distinct and contrary properties but as different degrees of one and the same property of matter; light was decomposed and water analysed; Lavoisier laid the first foundations of modern chemistry. At the same time Descartes, Newton, Leibnitz, and others devoted their genius to mathematical researches; and, enriched by their contributions, those sciences made rapid and giant strides. Man's scientific conception of the universe was reconstructed on altogether new lines, and many of the scientific theories which the medieval mind had incorporated in its synthetic view of the world were now finally and completely discredited. To mention only a few: There was an end of the idea that circular motion is the most perfect, and of the theory that the heavenly bodies

[1] p. 148 *seq.*

are exempt from generation and corruption. If there are spots on the sun, the immutability of the heavenly bodies becomes a respectable myth. Nor were the new mechanics long about exploding the theory of the *locus naturalis* of bodies. In short, there was much that needed to be reconstructed or modified.

"Now, the traditional astronomical, physical, and chemical theories were bound up with the principles of general metaphysics and cosmology by ties that were centuries old, though often indeed of a frail and fanciful character. Were not the principles dependent upon the theories, and did not the overthrow of the ancient science involve the ruin of the ancient philosophy? Not necessarily; and that for this reason: amid the debris of the demolished science there remained untouched quite sufficient data to support the constitutional doctrines of scholasticism. It is sufficiently obvious that philosophers and scientists alike should have closely watched and studied the scientific progress of the time in order to be able to pronounce upon the possibility or impossibility of adapting the new discoveries to the traditional philosophy. That is certainly what the princes of scholasticism would have done had they lived at such a critical turning point in the history of the sciences. We are aware from well-known and oft-quoted texts that they never meant to give all the scientific theories of their own time the value of established theses, but rather of more or less probable hypotheses whose disproof and rejection would in no wise compromise their metaphysics. So, for example, St. Thomas, when speaking of the movements of the planets, makes use of these significant words: 'Licet enim talibus suppositionibus factis apparentia salvarentur, non tamen oportet dicere has suppositiones esse veras, quia forte secundum aliquem alium modum, nondum ab hominibus comprehensum, apparentia circa stellas salvantur.' [1] And his disciple, Giles of Lessines, gives frequent expression to the same view. But, unfortunately, the reverse of all this was what actually took place. The deplorable attitude of

[1] This may thus be paraphrased:—"Though the hypothesis would explain the appearances, that does not prove it to be true, for the real explanation may be one not yet known to us."

the seventeenth-century peripatetics towards the science of their day was just the opposite of what it ought to have been. Far from courting or welcoming a possible alliance between their cherished philosophy and the new scientific discoveries they turned away in terror from the current theories lest they should be compelled to abandon their own out-of-date science. It is said that Melanchthon and Cremonini refused to look at the heavens through a telescope. And Galileo speaks of those Aristotelians who, 'rather than alter Aristotle's heavens in any particular, obstinately deny the reality of what is visible in the actual heavens.' The Aristotelian teaching they regarded as a sort of monument from which not a single stone could be extracted without upturning the whole. This it is that explains the obstinacy with which they tried to defend the discredited astronomy and physics of the thirteenth century, and the ridiculous attitude of the 'Aristotelians' in their widespread university controversies with the Cartesians. Those philosophers were shortsighted; they were apparently unable to distinguish the essential from the accessory; they failed to realise the possibility of abandoning certain arbitrary applications of metaphysics in the domain of the sciences without abandoning the metaphysic itself. Is it any wonder that they drew upon themselves the ridicule of the scientists? And these latter in turn made the scholastic *philosophy* responsible for the errors of medieval *science*, from which the *former had been declared inseparable.*

"When we remember that for very many scholasticism meant merely the old systems of astronomy and physics we can understand at least to some extent why they should treat it with such sarcasm. They were not long about discrediting a system that defended such mistaken views. The necessity of making a clean sweep of the past became more and more apparent. And some, not satisfied with condemning all scholasticism *en bloc*, went even so far as to condemn *all* philosophy. It is from this epoch of unparalleled progress in the sciences of observation that we may date not only the sharp distinction between common and scientific knowledge, but also the divorce of the latter from philosophy. The

more moderate among the scientists, while repudiating scholasticism with scorn, gave their adherence to some system or other of modern philosophy; for the latter had always professed its respect from the very commencement for the sensational scientific discoveries of the seventeenth century. To sum up: The contest that arose in the seventeenth century between the peripatetics and the scientists had no real bearing on the essential content of the scholastic teaching, but regarded mere side issues and secondary matters. The misunderstanding was indeed inevitable: it was almost if not altogether irremediable, and unfortunately it exists even still. The scholastics and the scientists of those days were both alike responsible for it: the latter would cut down the powerful oak tree of centuries on the pretext that it bore some rotten timber under its spreading foliage; while the former stupidly contended that its hoary head must not be touched at any cost—that by stripping it of a few withered branches it would be deprived of its very life."[1]

[1] I quote at length from de Wulf since he is a writer of the highest authority, but it should be added that others take a less pessimistic view of the so-called decadent period of scholasticism. For example, Duhem, a first-rate authority, says (in his "Essai sur la notion de théorie physique de Platon à Galilée," 1908, p. 71): "From the beginning of the fourteenth to the beginning of the fifteenth century the University of Paris upheld concerning scientific method a doctrine whose accuracy and depth far surpass anything which the world heard on this subject until the middle of the nineteenth century."

CHAPTER V

FACTS AND THEORIES: IMPORTANT DISTINCTION

IN a previous chapter something was said as to the methodology of Science, but the question was scarcely carried beyond the mere matter of the collection of facts. It is clear that Science, were it to begin and end its labours by the collection and registration of facts, would be a barren and uninteresting study. The collection of facts would be like the words in a dictionary—"fine, confused reading," without any interest until the hand of a master has welded them into prose or verse; or they would be like the heap of bricks from which, after the plan of the architect, there will arise the stately Elizabethan hall. But directly that Science begins to build a house with her bricks or facts she leaves the region of fact—more or less undoubted fact—as we shall see, for the land of surmise. She, in her turn, begins to philosophize and it is now that she comes into direct relations, or may come into them, with religious ideas. The truth is, of course, that Science cannot be, and ought not to be supposed to be, capable of being confined to the mere collection of facts without any relation to one another; for while she is so confined she must needs be sterile. To become the fertile mother which she ought to be, she must needs attempt the task of considering the relation of one fact to another. Yet the moment that she does begin to consider the relation of one fact to another and still more the relations of the facts of one branch of scientific study to those of some other branch, she enters the domain of philosophy; for she commences the rational study of one or of some of the problems involved in our effort to explain the universal order of things by their ultimate causes or principles.

It may seem a grandiose way of alluding to some very small deduction from facts, but in essence that is what it is; and when the deductions are really far-reaching it is quite obvious that they may come into serious conflict, or at least may appear to do so, with the findings of philosophy.

If, on the fullest consideration of all the facts of the case, it should appear that the findings are wholly irreconcilable, then one of three things must be the case: either the scientific man or the philosopher or both must be wrong.

Or both; for there is an all-important point too often forgotten, which is that because an explanation explains it is not, therefore, the true explanation. There may be twenty plausible explanations of a set of facts of which nineteen must be, and all the twenty may be, wholly wrong. Enthusiastic writers of popular treatises on science often seem to forget this important point. Because the doctrines of protective colouring or of sexual selection, for example, seem to explain, and as a matter of fact would explain a number of facts, it is therefore assumed that they must be true explanations. Which is a *non sequitur.* The more facts which a theory explains and the more wide apart from one another those facts are, the more likely it is to be true; but there is a considerable gulf set between extremely likely and perfectly certain. Many enthusiasts seem to take this gulf in their stride; at least they neglect to inform their followers that it has been passed. The wary traveller in the Land of Theories will be on the look out for the gulf, and will be quite clear, or should make himself so, that its passage is legitimate.

Substitute for the Philosopher in the above remarks the Theologian—for it is obvious that the difference of opinion is perhaps even more likely to arise between him and the man of Science than in the former case—and again the same three cases arise. In some at least it will be clear that the third alternative is the real solution and that neither party to the question has been wholly right and neither wholly wrong. In a word, the opposition between the two views comes to be recognised to be apparent rather than real. "Sometimes," says an author already quoted,[1]

[1] Mozley, *op. cit.*

"Science seems to threaten the very formulation of a spiritual existence, and some theory pushes forward into the first ranks which seems to convert our very personality into a development and form of matter. Men tremble at the approach of the giant who comes with uplifted arm to aim his blow; but if they only stand their ground the spell is broken, the descending stroke falls harmlessly upon us and the spectre vanishes. We shake ourselves and feel whole and untouched. All that is required in such cases is distinctly to see that A is not B. The theory of the correlation of vital and physical forces, while it reduces some life to the same head with material properties, does not touch the spiritual being or self; consciousness witnesses to that ego as distinct from the mere living bodily organism. The theory again that a living organism can develop itself from inorganic matter deals with the origination of one fact, while that which we are conscious of is another. The material science, even granting its pretensions, only advances as far as some facts which come under the head of life; it then stops upon the outer brink, and can only look from thence upon an unsolved personal being."

The most serious opposition naturally arises when some scientific theory challenges, or seems to challenge, a dogma of Theology. Of course in this case the attitude of the Catholic is perfectly clear, nor need he feel the least anxiety of mind. Unless everything which he, on wholly different grounds, believes to be true, is untrue, the theory which is giving trouble will either prove to be false or will be shown to be explicable in terms of the dogma. Those who have read their Newman will not require to be reminded that whilst implicitly all dogmatic truth is final, this does not contradict the undoubted fact that there is a development in our comprehension of the meaning of a dogma; and that our comprehension may be aided and our view as to the exact significance of the dogma in some one or more of its applications may be modified, indeed on various occasions has been modified, by the discoveries of science.

Hence, as will be shown from the quotation to be given from Fr. Hull's book at the end of this chapter, the extreme desirability of not being in a hurry to rush to the attack of

every or any new theory. But can a scientific fact ever really come into conflict with a Catholic dogma ? To this enquiry it may be quite confidently answered that, seeing that God is at once the Author of Revelation and of Nature, and that it is, therefore, impossible that there should be any conflict between the two, it is utterly impossible that a *Fact* of Science and a Dogma of Religion can come into conflict with one another. But a *Theory* of Science may very well conflict with a Dogma of Religion when the conditions above alluded to arise. We must now, even at the risk of some repetition, endeavour to make this matter of Scientific Theory or Hypothesis clear, for it underlies everything which will be dealt with in this book. Let us first consider the genesis of a Hypothesis. In so doing, let us not forget the attitude of Science, which is one of constant expectancy of new facts and of new theories, and of readiness to accept such theories as working hypotheses, though without definitely committing herself to their truth.

In the first place, then, scientific observers are constantly engaged in the revision of old facts and the search for new ; and this brings us to the point as to the acceptance of what is claimed to be a fact as really entitled to that name. Here we are dealing not with what is called a theory, but with an isolated case. Properly speaking, a theory is something which binds together a number of isolated facts and explains their relation to one another. But to the fact. It is, for example, an undeniable fact that human beings have skulls. That is plain and obvious and incontrovertible. It is a fact if there are any facts, if everything is not illusion. But let us take another case. Huxley discovered a certain substance in bottles containing dredgings from the deep sea which he considered to be the simplest form of life and named *Bathybius Haeckelii*. Now it will be observed that he did not say, " My theory is that this is living substance." He was quite clear that it was a living thing and he described it as such, just as another man might describe a new butterfly or a new bird. In this case, however, the fact turned out not to be a fact. A mistake had been made and a chemical compound accidentally formed had been taken for an organised and living thing. Huxley, the most candid of

men, at once owned his mistake, a most unpleasant thing to have to do, and the so-called fact disappeared save as one of the curiosities of Science. Here was a case of mistake as to what we may call a Central Fact; with respect to Subsidiary Facts there is far more reason for doubtfulness. In a later section of this book it will be necessary to devote a good deal of attention to the skulls of extinct races on this earth. The first question—what we may call the Central Fact—about each of these is "Is it a human skull?" Sometimes this question is not easy of resolution when asked of the fragments which have alone come to hand. But when it is answered, there are a whole series of other or Subsidiary Facts to be determined, all of which will be discussed in their proper place. The first thing which has to be settled is whether what appears to be what we have described as a Central Fact is a fact at all.

With regard to thousands upon thousands of these there is no kind of doubt possible. A group of these is brought together by means of a theory or hypothesis. It is published: it is submitted to scientific criticism. It may be shattered by that criticism and disappear from view, as many a hypothesis has done. Or it may survive and be accepted as a working hypothesis, and as such may prove of inestimable service to science, even though in the long run it may turn out to have been at least partially and perhaps wholly inaccurate. But all this time it remains what it has been from the beginning—the idea of a man's mind; and thus wholly different from an objective fact.

In strict logic or under the strict laws of logic it is difficult to see how anything in the nature of a Theory can ever be said to be definitely and irrefutably proved.

Formal logicians, I believe, would tell us that by their rules the heliocentric theory of the solar system is not proved to a demonstration. Yet no one doubts that explanation any more than anybody doubts the truth of Gravitation, though physicists are still unable to show what causes the results which are described under that name.

We may now proceed to consider an illustration of these remarks.

The fact that a buttercup, for example, has five or more

petals and numerous stamens is a fact which any person with eyes can demonstrate for himself at the proper season of the year, which no one will desire to dispute, and which has no relation to any religious dogma. But it does not carry us very far. Let us go a step farther and observe some thousands of buttercups. We find that they all have the same general characters, and we establish in our mind the idea not only that there is a single flower called a buttercup but that there are uncounted millions of buttercups every year. The next thing which we find is that there are a lot of other flowers which certainly are not buttercups but which have the same general characters. So that one of the first tasks to which botanists have to apply, and have applied, their minds is the arrangement of plants into classes. Linnæus tried to do this on an unnatural system—a system admitted by its author to be unnatural, since it grouped together in a wholly arbitrary manner plants really quite unrelated. Nevertheless, even this system, though non-natural, was a very useful one; for it at least effected this object, that it brought isolated facts into some sort of concordance with one another and afforded an opportunity for a further sorting out to take place.

It became clear before long, however, if indeed it was not clear from the first, that the Linnæan system grouped together plants whose real characters were not similar but widely opposed to one another, and this because the lines on which it worked were non-natural: and eventually there came into existence the so-called "natural" classification, which we owe very largely to the labours of de Jussieu in France and of Robert Brown in England. This system, so we think at present, does include in one group plants having common characteristics and perhaps a closer genetic relationship with one another than those of other groups. I ask my readers to note the importance of those last few words. For a moment, however, we may observe that in thus leaving the region of isolated facts for that of the construction of classes—categories we may call them for the time being—science has begun to enter the fields of philosophy. It may be admitted that she has not got far enough into them to come into any kind of

contact with the philosophers, still less with the theologians. But let us return to the last few words of the sentence above to which attention was called. Here we enter upon more debatable ground. No one will deny that the sweet-pea has certain characteristics which need not here be detailed. No one will deny that the common horse-bean has similar characteristics. No one will quarrel with their both being placed in the same family of Papilionaceæ. Few, if any, will dispute the theory that the sweet-pea and the bean, since they have not existed from the beginning of things, may have had a common ancestor. The theory is often expounded that all plants have come from a common ancestor—even that all living things have come from a common ancestor, if we may use so exalted a title for what is postulated as the primeval living cell. Yes, but let us see how far we are treading on rock in this matter and how far on less certain ground. So far as the characters of the plants are concerned there is no doubt. These are *facts*, that is to say if there is any reality in the things which we see, then the pea and the bean have the characteristics which are set down concerning them in the manuals of botany. In other words, we may give them the same credence that we do to the whiteness of snow, the coldness of ice, or any of the other natural facts which are made known to us through our senses.

Further, when the botanists bring them into groups by assembling them in the so-called Natural Orders we are still confronted by easily ascertainable facts, and would be wholly unjustified if we refused to admit them. But when we come to the next series of questions we are on very different ground. No person has ever seen or ever demonstrated the common ancestor of the bean and the sweet-pea. However likely it may be that they have had a common ancestor, the *fact* is still unproved; the common ancestor remains a matter of theory or hypothesis. And the same is still more true of the hypothetical primeval cell. In the very nature of things no one can possibly have seen this cell; and as a matter of fact up to the present, in spite of all the efforts of men of science, no one has ever discovered any absolutely irrefutable evidence in favour of what most people think

to have been the probable explanation of species. "It is ridiculous to ask for any such evidence!" This may be admitted, but what remains is that without such evidence the thing before us is not a *Fact* but a *Theory* or *Hypothesis*. It may be a well-established Theory or it may not. It may be held by every man of science or it may not. It still remains a Theory and, as such, is in a wholly different category from that of the ascertained and demonstrable fact. It may become a demonstrated Fact some day or it may not. Considering the finite nature of man's knowledge and the constant increase in his acquaintance with facts in the nature of things the latter is the more likely event. The Theory may hold the field for a long time and serve a most useful purpose while it does, as did the old chemical theory of the elements; and like that theory it may turn out to have been wholly untrue, even though at one time it was the teaching of all men of science. A person cannot refuse to believe a true scientific *fact*, such as that human beings have osseous backbones, and still retain a reputation for sanity. But, when he considers all that has happened even in recent years, perhaps especially in recent years, in the history of science, he can be pardoned if he suspends his opinion on any theory of science, and particularly if he suspends it when that theory appears to conflict with anything which he believes on higher grounds. He can and he may do this, when he would be insane if he asked leave to suspend his decision on the backbone question. More especially may he venture to suspend his opinion when he finds that men of science are not all of one mind on the point in question; indeed, under those circumstances, it would seem to be prudent for the ordinary person to suspend his judgement.

Thus a man who would refuse to believe in the Law of Gravitation would certainly be taking up a position very hard of justification, whereas if he contented himself with stating that Natural Selection was a very unsatisfactory explanation of the origin of species he may at least shelter himself behind the patent fact that men of science hold very widely divergent opinions as to the real value of that doctrine. When we are confronted with a difficulty of the

kind indicated in the preceding pages it will always be well for us to ask ourselves, "Are we dealing with a Fact or a Theory?" It is quite safe to say that, if there be any difficulty for us to deal with, it is caused by a Theory and not by a Fact: and, that being the case, it will then be necessary for us to make careful enquiries as to what facts the Theory is based upon, and how far it is really deducible from them before we yield our assent to it.

The points on which emphasis has just been laid will come up for consideration in specific cases more than once in these pages: meantime it will clear the way to have them briefly laid down in these preliminary observations.

It is part of the purpose of this book to state quite definitely and unhesitatingly what are the dicta of the Church in connection with scientific matters. They will be found, by those ignorant of the real state of the case, to be quite startlingly few in number. On the point with which we have been dealing nothing can be more specific or clear than the teaching contained in the Encyclical of Pope Leo XIII entitled "Providentissimus Deus":

"There can never," it states, "be any real discrepancy between the theologian and the physicist" (by which he means what is commonly called the man of science), "as long as each confines himself within his own lines, and both are careful, as St. Augustine warns us, 'not to make rash assertions, or to assert what is not known as known.' If dissension should arise between them, here is the rule also laid down by St. Augustine for the theologian: 'Whatever they can really demonstrate to be true of physical nature, we must show to be capable of reconciliation with our Scriptures: and whatever they assert in their treatises which is contrary to these Scriptures of ours, that is Catholic faith, we must either prove it as well as we can to be entirely false, or at all events we must, without the slightest hesitation, believe it to be so.' To understand how just is the rule here formulated we must remember, first, that the sacred writers, or to speak more accurately, the Holy Ghost 'who spoke by them, did not intend to teach men these things (that is to say, the essential nature of the

things of the visible universe), things in no way profitable unto salvation.' Hence they did not seek to penetrate the secrets of nature, but rather described and dealt with things in more or less figurative language, or in terms which were commonly used at the time, and which in many instances are in daily use at this day, even by the most eminent men of science.

" Ordinary speech primarily and properly describes what comes under the senses ; and somewhat in the same way the sacred writers—as the Angelic Doctor also reminds us —' went by what sensibly appeared,' or put down what God speaking to men, signified in the way men could understand and were accustomed to. The unshrinking defence of the Holy Scriptures, however, does not require that we should equally uphold all the opinions which each of the Fathers or the more recent interpreters have put forth in explaining it ; for it may be that, in commenting on passages where physical" (i.e. scientific) " matters occur, they have sometimes expressed the ideas of their own times, and thus made statements which in these days have been abandoned as incorrect. Hence, in their interpretations, we must carefully note what they lay down as belonging to faith, or as intimately connected with faith—what they are unanimous in. For ' in those things which do not come under the obligation of faith, the Saints were at liberty to hold divergent opinions just as we ourselves are,' according to the saying of St. Thomas. And in another place he says most admirably : ' When philosophers are agreed upon a point, and it is not contrary to our faith, it is safer, in my opinion, neither to lay down such a point as a dogma of faith, even though it is perhaps so presented by the philophers, nor to reject it as against faith, lest we thus give to the wise of this world an occasion of despising our faith.' The Catholic interpreter, although he should show that those facts of natural science which investigators affirm to be now quite certain are not contrary to the Scripture rightly explained, must nevertheless always bear in mind, that much which has been held as proved certain has on further examination turned out not to be so."

There are several conclusions which may be drawn

from what has been said in this chapter, perhaps the most important of them being the wisdom of the advice which recommends the defenders of religion, in the popular phrase of the day, to " wait and see." Careful thought and consideration of the facts will often lead to a better appreciation of the exact bearings of the opinion of one side and those of the other.

I shall conclude this long but essential chapter with a lengthy quotation from Fr. Hull, whose authority as a theologian will excuse me for preferring his statement to anything which I could myself construct. Writing as to the proper policy of the Church confronted with a new idea and having stated that it consists in suspending judgement until the matter has been thoroughly thrashed out, whilst at the same time taking such steps as are necessary to prevent the consciences of less educated Catholics from being wounded, he proceeds : " Down to a generation or two ago it was the general belief of Christians that the deluge of Noah covered the whole earth, and that it is so described in the most explicit terms in the Bible. Certain new considerations, mainly drawn from Geology, led specialists to the contrary conclusion that the deluge was by no means universal, but was a comparatively local phenomenon ; widespread enough to cover the area occupied by mankind at that time, but not much more. The view at first found considerable opposition in theological circles ; partly because the restriction of the area of the flood was not as yet demonstrated beyond question, and partly because it ran counter to the literal text of the Scripture as universally understood by its interpreters. Fortunately the view did not attain such sudden publicity as to cause a widespread sensation, and so no crisis arose. The partial-deluge view gradually came to look more and more feasible, and the possibility of interpreting Scripture accordingly became more and more evident. The new view gradually filtered down from learned circles to the man in the street, so that nowadays the partiality of the deluge is a matter of commonplace knowledge among all educated Christians, and is even taught to the rising generation in elementary schools.

"But suppose this denial of the universality of the deluge

had been suddenly sprung upon the world in general, and bruited about in the streets and squares of every city. It would come as a shock, not only to theologians of the conservative school but also and above all to the faithful laity, who would look upon it as a sudden tactic of unbelief, and the upsetting of their simple faith in the word of God. Suppose, moreover, that those who embraced and propagated the new view were most of them men prone to be enamoured of 'progress' and impatient of authority, while its opponents were men of unquestionable orthodoxy and edifying Catholic spirit. Before long a crisis would certainly arise. The cry would go forth that infidelity was spreading and the faith in danger. In such an emergency the Church authorities would feel the necessity of a remedy; and this remedy might easily take the form of condemning the new doctrine—not precisely because it was ascertained to be false or contrary to divine truth, but because its psychological effects on the minds of the faithful were practically destructive of their faith. In other words, the doctrine would have to be discountenanced for the time, not as false but as rash or unsafe, and its propagation as premature.

"Other instances might easily be multiplied. For instance, the discovery two generations ago by geologists of the extreme antiquity of man on the earth was popularly regarded as an entire refutation of the Bible record, simply because people believed that the date of Adam was fixed by the Bible; and I remember a young man who actually became an infidel through reading a book of this kind. Similarly in Italy, in the time of Galileo, it is quite likely that a number of people, accustomed to understand the miracle of Joshua in its literal terms, felt that the truth of the Bible was gone when it became clear that Joshua could not have caused the sun to stand still, because it was standing still already. In such a contingency a strong and assertive policy is required."[1]

No doubt this will seem a hard saying to those outside the Church. To many such it is simply incomprehensible that any person or any body should concern itself respecting

[1] "Galileo," Catholic Truth Society, 1s., p. 105 *seq.*

so nebulous and problematical a thing as the soul and its future prospects. But if one is to understand anything about any particular organisation, it is absolutely necessary to try to comprehend its standpoint and first principles.

This book is written chiefly for the information of Catholics, who will not require instruction in the first principles of their religion. But it may also come under the eyes of non-Catholics, who may be presumed to be seeking information as to our ideas. It is as well for them to understand that the central object, the *raison d'être* of the Church, is the salvation of souls. Bearing this cardinal fact in mind it is clear that if at any time it appeared that the premature brandishing in the face of the public of some doubtful and disputable idea was endangering souls, it might be the duty of the Church to forbid those of her children who were not educated enough to appreciate the matter in all its bearings, and to bring to bear upon it really valuable criticism, favourable or unfavourable, to abstain from discussing it. And further it might be her duty to instruct those who were capable of discussing it to do so amongst themselves, and, above all things, not to proclaim as absolute truth what might turn out to be only partially true. All these things might and very probably would be done, though nobody now would attempt to defend the action of the Holy Office at the time of and in the case of Galileo. The modern attitude is summed up in the words of Leo XIII—"we proclaim that every wise thought and every useful discovery ought to be gladly welcomed and gratefully received by us, whatever its origin may have been." On these lines was founded the Institute of Catholic Philosophy in the University of Louvain, from which has come forth so much valuable constructive work, scientific as well as philosophical.

CHAPTER VI

"SPACE" AND THE ETHER OF SPACE

WHEN any person not a professed physicist approaches the question of the ultimate composition of the Universe, he cannot fail to be impressed with the extreme caution which authorities on that subject exhibit in dealing with the hypotheses of the day; with the hesitation which they obviously feel in definitely and dogmatically committing themselves to any special view; nay even with the scepticism which some of them express, not only as to present-day theories but even as to the possibility of attaining to any true knowledge of the real state of affairs. Thus, for example, Poincaré, a distinguished French man of science recently dead, writes in very pragmatist language:[1] "Principles are conventions and definitions in disguise. They are, however, deduced from experimental laws, and these laws have, so to speak, been erected into principles to which our mind attributes an absolute value. . . . The fundamental propositions of geometry, for instance Euclid's postulate, are only conventions; and it is quite as unreasonable to ask if they are true or false as to ask if the metric system is true or false. Only, these conventions are convenient. . . . Whether the ether exists or not matters little: let us leave that to the metaphysicians; what is essential for us is that everything happens as if it existed, and that this hypothesis is found to be suitable for the explanation of phenomena. After all, have we any other reason for believing in the existence of material objects? That, too, is only a convenient hypothesis." The same attitude has been commented on and criticised by Schuster.[2] "Vagueness, which

[1] As quoted by Lodge, "Continuity," p. 18.
[2] As quoted by Lodge, *op. cit.*, p. 17.

used to be recognised as our great enemy, is now being enshrined as an idol to be worshipped. We may never know what constitutes atoms, or what is the real structure of the ether; why trouble, therefore, it is said, to find out more about them? Is it not safer, on the contrary, to confine ourselves to a general talk on entropy, luminiferous vectors, and undefined symbols expressing vaguely certain physical relationships? What really lies at the bottom of the great fascination which these new doctrines exert on the present generation is sheer cowardice; the fear of having its errors brought home to it. . . . I believe this doctrine to be fatal to a healthy development of science. Granting the impossibility of penetrating beyond the most superficial layers of observed phenomena, I would put the distinction between the two attitudes of mind in this way: One glorifies our ignorance, while the other accepts it as a regrettable necessity."

When, therefore, we approach the study of the questions which have to be dealt with in this and the next chapter we must ever bear in mind that we are not dealing with certitudes of science but only with theories more or less well established in some cases; perhaps highly likely in others; in certain cases only tentatively advanced.

With this preliminary caution we may now proceed to consider what is placed before us for acceptance by the highest authorities on that subject with respect to the Ether of Space or the Luminiferous Ether or simply the Ether.[1]

In the first place, why the Ether of Space? Space is often spoken of as "infinite," and no one can have read

[1] For the sake of readers unfamiliar with the terminology of science it may be well to point out that the entity with which we are dealing in this chapter has nothing whatever to do with the fluid used as an anæsthetic for operative purposes. Our subject has the prior right to the name, no doubt, but for one person who has heard of the ether of space there must be hundreds who have personally experienced the effects of the ether of the pharmacist. Hence a very natural confusion. In the same way the adjective "ethereal" has come to have a secondary significance which has assumed so much greater importance than that which legitimately attaches to it as to make it practically unusable in its proper way. Hence "etheric" is sometimes used in its stead when the properties of the ether of space are under consideration. It ought also to be pointed out that the Theory of the Ether is selected as one of prominence at the present day, though it cannot be said to be proved to universal satisfaction.

much poetry without having discovered that it is commonly described as "empty." But empty it is not if the ether really exists, for wherever space is—that is, throughout the universe—there also is the ether.[1] Were it not so we should be in a great difficulty as to how to explain the undoubted occurrence of action at a distance. Matter, it is commonly held, cannot act where it is not but only where it is. If space is really empty how is it that the sun and moon exercise influence over the earth? "Technical action at a distance is impossible. A body can only act immediately on what it is in contact with; it must be by the action of contiguous particles—that is, practically, through a continuous medium, that force can be transmitted across space. Radiation is not the only thing the earth feels from the sun; there is in addition its gigantic gravitative pull, *a force or tension more than what a million million steel rods, each seventeen feet in diameter, could stand.* What mechanism transmits this gigantic force? Again, take a steel bar itself when violently stretched, with how great tenacity its parts cling together! Yet its particles are not in absolute contact, they are only virtually attached to each other by means of the universal connecting medium—the ether—a medium that must be competent to transmit the greatest stresses which our knowledge of gravitation and of cohesion shows us to exist."[2] It must not for a moment be supposed that the ether only exists in what is popularly called space. Space for many people is a kind of ill-defined area which begins somewhere about the point where our atmosphere ceases. Of course such is not the case. The ether is omnipresent. What is more, apart altogether from its relations to the structure of matter, which are to be dealt with in the following chapter, it interpenetrates all matter, indeed it would be much more accurate to say that all matter is interpenetrated by the ether. It is exceedingly difficult to bring this relationship before the mind of the reader unaccustomed to scientific ideas. Perhaps he may obtain an absurdly rough but approximate idea by thinking of a currant bun

[1] See end of this chapter for a note on Space.

[2] Lodge, "Ether of Space," Harper, London and New York, 1909, p. 26. Italics as in original.

where the floury part is the ether and the currants are the ultimate constituents of the matter itself. It is the very fact of its omnipresence that makes it so difficult to study, so hard to detect and to realise, for, as Sir Oliver Lodge most happily puts it, "The last thing that a deep-sea fish could discover would be water."[1] When we have to do with a thing which is absolutely uniform and universally present, it is obvious that its detection must be a matter of singular difficulty. It might be urged by one unfamiliar with the characteristics of ether that the air around us is for all practical purposes, so far as we are concerned, uniform and universal; yet we are able to detect its existence. The ether is frictionless, as we shall shortly see. Air is not; and it is by the friction of its own currents, winds or breezes, or by our rapid passage through it that we appreciate its existence. There are other points, but this will suffice.

It is also, as we have seen, called the Luminiferous Ether, and this name it owes to the fact that it bears the light across inter-stellar space. It is the transmitter of radiations, and when we feel the warmth of the sun or the heat of a flame it is because the radiations are conveyed to us by the ether. In fact it is through the ether that nearly all the energy now informing all movable things on this earth has reached us. The motor-car which rushes along the road, the train, the steamship, the manufactory—these owe their energy to that which came to the earth from the sun in ages long gone by and was stored up to be employed by us in these later days. How did these sunbeams make their journey over the 90,000,000 miles which separate us from the place of their origin? It is inconceivable that they could travel, so to speak, through an absolute vacuum: they must have been transmitted, as the sunbeams of to-day are being transmitted, by some medium, and that medium is what we call the ether. Further, we know that it transmits light, and it may be added all the other influences which traverse it, at a quite definite rate, namely, 185,000 miles per second. This is a characteristic velocity, just as the velocity of sound through air, at 1200 feet

[1] "Continuity," p. 109.

per second, is the characteristic velocity of the atmosphere surrounding this earth. "Radiations," says Mr. Soddy,[1] "be they light or heat, whatever their colour or wave-length, X-rays, the ether-waves employed in wireless telegraphy, magnetic disturbances, whether they reach us from the sun as the accompaniment of solar storms, or whether, lastly, they circulate around the space surrounding a wire in which a current of electricity is being started or stopped—all travel through space with the speed of light. Sound is the vibration of the air, and all the gamut of sounds and noises are essentially air disturbances of the same type. Radiation is the vibration of the ether, and all the various phenomena just enumerated are due to electro-magnetic changes accompanying the alteration either of the speed or direction of motion of electrons. The ether, so far as we know, vibrates only in this one way, and the vibrations are transmitted only with one velocity."[2]

The point with which we are now dealing is further summed up by Sir Oliver Lodge,[3] whose words may be quoted *in extenso*: "Radiation," he says, "conspicuously comes to us from the sun. If any free or ordinary matter exists in the intervening space, it must be an exceedingly rare gas. In other words, it must consist of scattered particles of matter, some big enough to be called lumps, some so

[1] "Matter and Energy," Home University Library, p. 186.

[2] The distinction between transmission by the air and transmission by the ether may perhaps be made clearer to the general reader by the following: Many persons will have seen the experiment in which when a sounding-fork of a certain pitch is struck, its note is echoed by an identical note in another sounding-fork distant from and in no way connected with the first but of the same pitch. Or, if they have not seen this experiment, they can scarcely fail at some time or another to have noticed that a note sounded on a violin or other musical instrument, even on a wine-glass, will be echoed by some object capable of vibrating and "tuned" to the same note as that which has excited it. Perhaps it should be added that in all these cases the second or excited note is a real note, quite as real as that which caused it. Such effects are due to vibrations conducted by the air and travel with the characteristic velocity alluded to above. But there is another experiment in which, instead of two sounding-forks, two magnets, which must be identical in character, are suspended at some distance from one another but in no way connected with one another. Set one of them swinging. There is no sound and no disturbance of the air, but the other magnet will also be set swinging to a small extent. Here the waves which have produced the motion have not travelled through the air but through a totally different medium, namely, the ether of space.

[3] "Ether of Space," p. 22.

small as to be merely atoms, but each with a considerable gap between it and its neighbour. Such isolated particles are absolutely incompetent to transmit light. And, parenthetically, I may say that no form of ordinary matter, solid, liquid, or gaseous, is competent to transmit a thing travelling with the speed and subject to the known laws of light. For the conveyance of radiation or light all ordinary matter is not only incompetent, but hopelessly and absurdly incompetent. If this radiation is a thing transmitted by anything at all, it must be by something *sui generis*. But it is transmitted,—for it takes time on the journey, travelling at a well-known and definite speed ; and it is a quivering or periodic disturbance, falling under the general category of wave-motion. Nothing is more certain than that."

From all this we may conclude that the ether is a real entity, not a philosophical creation invented to explain certain facts, and we may proceed to consider what characters physicists believe it to possess. In detailing these I shall freely avail myself of quotations from the recent writings of those most competent to speak on the subject from long and careful study. This will, I think, convey a much more adequate idea of the present state of opinion on the matter than would be conveyed by any attempt on my part to paraphrase their writings. And I specially rely on the writings of Sir Oliver Lodge, since in this country and elsewhere he may be regarded in an especial sense as the prophet of the ether.

In the first place, then, the ether is exceedingly dense, by far the densest thing in the universe. It is "massive and substantial beyond conception. It is turning out to be by far the most substantial thing—perhaps the only substantial thing—in the material universe. Compared to ether the densest matter, such as lead or gold, is a filmy gossamer structure ; like a comet's tail or a milky way, or like a salt in very dilute solution."[1] Or again : "As to its density, it must be far greater than that of any form of matter, millions of times denser than lead or platinum."[2]

Yet it is not infinitely dense—if indeed any real meaning

[1] "Ether of Space," p. xiv. [2] "Continuity," p. 33.

attaches to the word infinite in this connection. " It may be said, why assume any finite density for the ether at all? Why not assume that, as it is infinitely continuous, so it is infinitely dense, whatever that may mean—and that all its properties are infinite? This might be possible were it not for the velocity of light. By transmitting waves at a finite and measurable speed, the ether has given itself away, and has let in all the possibilities of calculation and numerical statement. Its properties are thereby exhibited as essentially finite—however infinite the whole extent of it may turn out to be."

Yet matter moves through the ether with perfect freedom; it is, in other words, quite frictionless. To anyone unfamiliar with physics this seems a most contradictory statement, having regard to what has just been said as to its enormous density, but it appears that " viscosity is not a function of density; the two are not necessarily connected."[1] Those who desire to comprehend more fully the facts upon which this statement are based may be recommended to study the account of the Ether Machine given in the " Ether of Space."[2] This, it may be very briefly stated, consists primarily of a couple of large steel disks a yard in diameter and so arranged as to be capable of being spun so fast as to be in danger of flying in pieces. By means of mirrors beams of light were sent round and round these whirling disks at times so close as actually to graze them. It is clear that if the ether were gripped and dragged round ever so little by the whirling disks, this ought to be shown to demonstration. The demonstration, it may be added, would take place through the observation of " interference bands," to explain which would take us much too far afield. Suffice it to say that the acceleration, if there, could be tested by perfectly well-known physical methods. The experiment, after allowing for spurious results, showed that the velocity was not affected by so much as one-tenth per cent of the velocity of the moving matter, so that practically we may say that the Ether of Space is never carried forward, presumably not even by a planet. " So

[1] " Continuity," p. 34. [2] p. 77.

far as experiment has gone, our conclusion is that the viscosity or fluid friction of the ether is zero."[1]

Finally, so far as we are concerned with it in this chapter, it is incompressible. "The fundamental medium filling all space, if there be such, *must*, in my judgment, be ultimately incompressible; otherwise it would be composed of parts, and we should have to seek for something still more fundamental to fill the interstices."[2]

With its relation to what is known as matter I shall deal in the next chapter, and until the theories there to be discussed have been passed under review it will also be convenient to defer any remarks as to the bearing of these things upon the teachings of the Church or their bearing upon philosophical ideas. But before concluding it may be well to summarise what has been stated as to the ether of space.

It is omnipresent, and fills what might otherwise really be "empty" space. It transmits the vibrations of light and other vibrations at a definite velocity. It permeates all matter than which it is enormously denser. It is perfectly frictionless and ultimately incompressible.

To the ordinary reader—indeed to almost any person, not a professed physicist—these attributes will appear contradictory and even incredible. Yet we are told that we must believe them and that they are deducible from the one fact which we know about the ether, the one secret which it gives away—namely, the rate at which it transmits light. It is a curious fact, yet there seems to be no doubt about it, that there are persons who cheerfully and without difficulty accept the fact of the ether, contradictory as its attributes are and modest as is the amount of evidence which we have for its existence, yet who wholly refuse to believe in the existence of the Creator, or at least proclaim that there is not sufficient evidence to compel belief in the existence of One whose attributes appear to them to be so contradictory. Yet to others it would seem that God makes Himself much more obvious and undeniable in His creation than He has made obvious the ether through its power of transmission of light.

[1] "Ether of Space," p. 77. [2] *Ibid.*, p. 82.

Note to Chapter VI.—The following note on the difficult question of "Space" in relation to the "Ether" has been kindly furnished to me by my learned friend Fr. Maher, D. Lit., whose useful suggestions here and elsewhere I wish again to acknowledge. The metaphysics of the conception of Space are difficult in all philosophies. The chief points in the Scholastic system are these: We must clearly distinguish between "actual" or "real" space and "possible" space. The former corresponds to or is co-extensive with the entire created material universe. It is, therefore, an actual well-defined area. According to the current scientific theory it is supposed to be pervaded throughout by the "Ether." This ether is created, is extended, is not spirit but some form of matter or material stuff, whether made of electrons or molecules, gaseous or solid or liquid, and whatever be its relation to the other coagulated realities immersed in it which we call "matter" or "bodies."

The whole bun must have been created—dough as well as currants!—and most probably all together. That creation thereby brought into existence "actual" or "real" space. Now before that creation there was nothing there—and no "there," for God, being a spirit, does not Himself exist in space or constitute space by His being.

There was merely the possibility that God might create extended material body which would carry with it into existence and determine so much actual or real space—a mental conception, an *ens ideale*. Now "outside" the sphere of the created material universe there is similarly at present *nothing*—merely the possibility of more material creations and such possibility is in itself nothing "real" or "actual"—merely an *ens ideale*. "Real" or "Actual" space is then finite, not infinite, and was actualised or received determinate existence by the creation of matter with its ocean of ether. Our imagination tends to ascribe to possible space a real actual existence independently of the material universe and to set it up as an entity distinct from God, indeed some philosophers have made it such. In reality "possible" space is not an *ens reale*—a real being—any more than any other possibility, such as the possibility of an angel or of a two-headed horse before an angel or a horse of the kind had been created. When we say that space is "infinite" we must not understand the space filled with ether or actualised material reality in any form: this is as strictly limited as a log of wood or a cloud of smoke. Only God is actually infinite. But we may say that possibilities are infinite, and so potential, or possible space.

CHAPTER VII

MATTER AND THE ELECTRICAL THEORY OF MATTER

HAVING thus dealt with the theories of to-day concerning the ether we are in a position to turn our attention to the highly contentious and difficult question of the nature of Matter. In this connection it may first be noted that by far the greater part of that which is now taught or thought concerning matter and its nature lies outside the realm of actually ascertained fact and within that of theory. Moreover, theory in connection with this subject is of a constantly fluctuating character, so much so that a good deal of what is now being set down here by the present writer may very possibly be out of date and disregarded by physicists before it appears in print. Indeed parts of it may be out of date at this moment with those who really know, for the present writer has no claim to be considered a physicist and can only avail himself of ordinary text-books in making this sketch.

This, however, it will effect : it will teach the lesson that a scientific theory is not a revelation given once for all and unchangeable, which is the kind of idea that too many manuals would like to impress upon their readers. To a considerable extent this is the lesson of this book, and it can be learnt from physics as it can from chemistry or from biology. And it will be still more strikingly evinced if the views here set down should have become old-fashioned during the interval which must elapse between the writing and the publishing of a book.

The fact is that we *know*—that is, have actual verifiable knowledge of—practically nothing as to the real nature of matter. But there are very definite theories which may—

or may not—some day or another come to be demonstrated as facts. With these we have now to deal, and the very imperfect historical sketch which it will be necessary to give will show how fundamental have been some of the fluctuations in opinion. The scholastic doctrine of Matter and Form has yet to be dealt with; so, for the moment, all that need be said is that during the Middle Ages the prevalent idea, founded on Aristotle's teaching, was that there existed —as a concept at any rate—a *materia prima* or *prothyle* which was regarded as a substratum common to all the forms of matter known to us. This fundamental identity being allowed, it is clear that it might be possible for human art to cause the *materia* existing under the form of one kind of substance to take upon itself a modification of some other kind, and be thus converted into a material substance of a totally different kind. This was the underlying theory of alchemy—that if lead and gold were fundamentally identical there was no reason why some method might not be discovered whereby the less could be transmuted into the more precious metal.

Such was the view disputed by Richard Boyle in his "Skyptical Chymist" (1661) and abandoned in favour of that which held sway over the scientific world until yesterday. According to that theory there were a certain number of substances known as Elements, amounting in number, at the time that radio-activity was discovered, to some eighty or ninety. Of these some are ubiquitous, such as sodium; some, like erbium, are exceedingly rare, at least on our earth. These elements could not be changed into one another nor further split up.

But even these were not simple or continuous substances. It was held then, just as it is now, that all matter is discrete or grained; the grains were what are called molecules, a molecule being the smallest amount of any compound which could exist separately—that is, whilst[1] still possessing the properties of that compound. It will be observed that the term compound is used; with regard to the elements it may be said that whilst occasionally the molecule and the atom

[1] The Molecule is the physical unit—what the ancients (and even Dalton) called "atom."

are the same, such is not usually the case. In all other cases, and in all compounds, the molecule is made up of atoms, the atom being conceived as the smallest portion of any element—the portion beyond which subdivision could not go ; the ultimate particle of that element.

Let us take the common instance given in all books on the subject—that of water. A very small amount of imagination will enable us to see that if we proceeded far enough in the subdivision of a spoonful of water we should come to a point where no further subdivision was possible. We should then have arrived at the molecule of water : but we should not have arrived at an entity which was indivisible, for, theoretically of course, if we applied the methods of electrolysis to our molecule of water we could split it up into two parts of the gas Hydrogen and one of the gas Oxygen. Here at length, according to the views with which we are concerned, we should have arrived at an ultimate and indivisible entity in the shape of the atom. Dalton, in 1803, formulated what is known as the Atomic Theory, with which we cannot here concern ourselves. Suffice it to say that it established an order and method in the combinations of various elements with one another so as to form the various chemical compounds ; and that, though ideas as to the ultimate nature of the atom have been, as we shall see, profoundly modified, the Atomic Theory remains just as useful and valuable to the chemist of to-day as it was to his predecessor of the days before radioactivity had been discovered. In 1815 Prout suggested that the atomic weights of all the elements were integral multiples of that of Hydrogen (which is usually taken as 1). Subsequent experiments have discredited this hypothesis ; yet the approaches of the atomic weights to whole numbers are too close and too frequent to be regarded as purely accidental.

Consider the first, i.e. the lightest twenty-five elements. If the values were chance-distributed, we might expect *five* elements in twenty-five to have an atomic weight within $=0{\cdot}1$ of an integer. As a matter of fact (prescinding from $H=1$ or else $O=16$) we have no less than *twenty* such elements. In 1865 Newlands proposed the " law of octaves." He showed that the elements when arranged in the order

of their atomic weights exhibited a regular recurrence of properties. In 1869 Mendeleeff completely formulated the famous periodic law: that all the physical properties (malleability, heat-conductivity and expansion, electro-chemical character, etc.) are periodic or regularly recurrent functions of their atomic weights. It is a remarkable fact that three gaps in Mendeleeff's table have since been filled up by newly discovered metals.

It is quite impossible here to give the facts upon which the statements now to be made are founded: for these, readers must be referred to the various manuals quoted in the footnotes. All that can here be done is to give the barest outline of the chief points which constitute the marvellous conception of the physicists of to-day, the Electrical Theory of Matter. No doubt philosophers and men of science were always restive under the idea of such a multiplication of entities as the Theory of Elements necessitated, and facts were gradually brought to light which indubitably pointed to something common to all the elementary atoms—that is, that the eighty or ninety substances of which we have been speaking were not intrinsically, unalterably and *ab initio* different from one another, but that there was in reality only one kind of matter underlying all its manifestations. It is only in recent years that we have obtained unequivocal evidence of something common, and, strange to say, this common constituent turns out to be, not, as Prout supposed, the atom of Hydrogen, but the atom of Electricity—the Electron.

Everybody is aware that there are commonly supposed to be two kinds of electricity commonly called positive and negative, and represented respectively by the signs + and —. Whether there are actually two kinds or not is not quite clear; what is certain is that up to the present time that form which most unfortunately came to be named negative is the only one which has as yet been isolated from the rest of an atom of matter. "An electron," says Sir Oliver Lodge,[1] "is the natural unit of negative electricity, and it may not be long before the natural unit of positive electricity is found too. But concerning the nature of the positive

[1] "Continuity," p. 28.

unit there is at present some division into opposite camps. One school prefers to regard the unit of positive electricity as a homogeneous sphere, the size of an atom, in which electrons revolve in simple harmonic orbits and constitute nearly the whole effective mass. Another school, while appreciating the simplicity and ingenuity and beauty of the details of this conception, and the skill with which it has been worked out, yet thinks the evidence more in favour of a minute central positive nucleus, or nucleus-group, of practically atomic mass ; with electrons, larger—i.e. less concentrated—and therefore less massive than itself, revolving round it in astronomical orbits. While from yet another point of view it is insisted that positive and negative electrons can only differ skew-symmetrically, one being like the image of the other in a mirror, and that the mode in which they are grouped to form an atom remains for future discovery. But no one doubts that electricity is ultimately atomic." The Atom, it appears, must be thought of as made up of electrons which are electrical units. But electricity is defined as ether-strain or ether-shear, and, without going into technicalities, it is ether modified in some way or another. From all of which it follows that, in the last analysis, all matter is modified ether, interpenetrated by unmodified ether as mentioned in the previous chapter.

It is quite clear that this conception is one of vast importance and that, if established, it means an extraordinary simplification of our ideas of matter. When we come to take this theory into consideration a question naturally arises in our minds ; what is the exact kind of modification which differentiates the modified ether of matter from the unmodified ether by which it is interpenetrated ? Is it a condensation of ether or a rarefaction, or what is the modification with which we have to do ? On this point Sir Oliver Lodge writes as follows : " The ether being incompressible, and an electron being supposed composed simply and solely of ether, it follows that it cannot be either a condensation or a rarefaction of that material, but must be some singularity of structure, or some portion otherwise differentiated. It might, for instance, be something analogous to a vortex

ring, differentiated kinetically, i.e. by reason of its rotational motion, from the remainder of the ether; or it might be differentiated statically, and be something which would have to be called a strain-centre or a region of twist, or something which cannot be very clearly at present imagined with any security; though various suggestions have been made in that direction. The simplest plan for us is to think of it somewhat as we think of a knot on a piece of string. The knot differs in no respect from the rest of the string except in its tied-up structure; it is of the same density with the rest, and yet it is differentiated from the rest; and, in order to cease to be a knot, would have to be untied —a process which as yet we have not learned how to apply to an electron. If ever such a procedure becomes possible, then electrons will thereby be resolved into the general body of the undifferentiated ether of space—that part which is independent of what we call 'matter.' The important notion for present purposes is merely this: that the density of the undifferentiated or simple ether, and the density of the tied-up or be-knotted or otherwise modified ether constituting an electron, are one and the same."[1]

If we assimilate this idea together with that which deals with the interpenetration of matter by ether we shall see our way through the next difficulty which confronts us, namely: Unmodified ether is the densest entity known. Modified ether or matter is not an attenuation or rarefaction of it. How is it then that we must think of matter as being of a texture comparable with gossamer?

Matter is "gossamer" in the same sense as a cobweb is gossamer; not because the actual substance of each fibre is of specially light material, but because the whole average of the cobweb is so. So it is in matter: the space actually filled by electrons is remarkably small. The space "occupied" by them in the sense in which soldiers occupy a country, is large and is what appeals to us as matter: in a word, it is the cobweb of the illustration. The particles themselves, being composed of ether, must be of the same density as ether. The average or group density is small, simply because the particles really fill so small a proportion

[1] "Ether of Space," p. 82.

of the space, a point which we have yet to deal with. The rest of the space is occupied by unmodified ether, which forms no part of the matter. The interstices of a cobweb are filled with air, yet the air is no part of the cobweb. The analogy is not fully accurate, but it may serve to clear up the point we are dealing with. At any rate we may pass on to our next point, namely, the relative size of some of the objects with which we have been dealing in this chapter and the relative proportions of the electrons and the undifferentiated ether which surrounds them.

The molecule of Hydrogen, which is the lightest known, may serve for a starting-point. It would require that about two million such molecules should be set side by side in a row in order to occupy one millimetre, or, in other words, one twenty-fifth of an inch. It requires fifteen thousand million million million of them to make up one single grain in weight. This is minute enough in all conscience, but it is relatively to the electron positively enormous. For, as Sir J. J. Thomson has shown, the electron possesses a mass about one-thousandth of the atom of hydrogen—the lightest atom of all, as we have already learnt.

In the words of Sir Oliver Lodge, "It may be convenient here to emphasize the dimensions of an electron, for the arguments in favour of that size are very strong though not absolutely conclusive: we are sure that their mass is of the order one-thousandth of the atomic mass of hydrogen, and we are sure that if they are purely and solely electrical their size must be one-hundred thousandth of the linear dimensions of an atom; a size with which their penetrating power and other behaviour is quite consistent. Assuming this estimate to be true, it is noteworthy how very small these electrical particles are, compared with the atom of matter to which they are attached. If an electron is represented by a sphere an inch in diameter, the diameter of an atom of matter on the same scale is a mile and a half. Or if an atom of matter is represented by the size of this theatre[1] an electron is represented

[1] The Sheldonian Theatre at Oxford, a building capable of accommodating a large number of persons, in which this, the Romanes Lecture for 1903, was delivered.

on the same scale by a printer's full stop."[1] And as regards the relations of the electrons within the atom he adds: "An atom is not a large thing, but if it is composed of electrons, the spaces between them are enormous compared with their size—as great, relatively, as are the spaces between the planets in the solar system."

From what has just been said we can now begin to form a better idea of what has already been insisted upon—namely, the gossamer nature of matter; since, relatively speaking, the interstices are so enormously greater than the particles themselves. Some have thought that these electrons within the atom not only occupy towards one another positions which have been compared to those of the planets of our system in space but have further thought that they may revolve around some centre as the planets do in space, thus forming a kind of microcosm comparable with that portion of the Universe to which we belong, which again may quite possibly be but a very small fragment of the Universe as known to its Maker. These are, of course, only surmises; but they serve to intensify the feeling of awe and amazement with which any person gifted with the very slightest shred of imagination must contemplate the wonderful ideas just brought under his notice. One thing, at least, is not an imaginary statement: the atoms are in motion. This is perhaps one of the most difficult of all the ideas concerning matter, for nothing less movable or, more correctly put, less possessed of motion in itself than a huge block of marble one can hardly conceive. Yet nothing can be more certain than that its atoms are in a state of even violent motion. We get some clear proof to our minds that what we call solid matter does move when we learn that, if a block of gold and a block of lead be placed side by side and left in that position, it will be found after lapse of time that the originally pure block of gold has come to contain some lead, whilst the block of lead in its turn has become, so to speak, infected with gold—in other words, some of the gold has moved into the lead and *vice versa*. Finally, we have to learn that matter, even its molecules, can and does undergo spontaneous change or

[1] Lodge, "Modern Views on Matter," Romanes Lecture, 1903, p. 8.

evolution. This fact completely upsets all that was believed but a few years ago. The statement on this point made by Clerk Maxwell, one of the most distinguished physicists of his time, in the ninth edition of the "Encyclopædia Britannica" has frequently been quoted as giving the final—so it was thought—and definite opinion as to the fixity of molecules. Even at the risk of bringing this under the notice of those already familiar with it, it may not be amiss to quote it, especially in view of certain matters which will come under consideration in the next chapter.

Clerk Maxwell in the article in question details fully the characteristics of the atom or molecule. Having drawn special attention to the rates of its vibrations which the spectroscope reveals, he continues: "It is the equality of these spaces and time-constants for all molecules of the same kind which we have next to consider. We have seen that the very different circumstances in which different molecules of the same kind have been placed have not, even in the course of many ages, produced any appreciable difference in the value of these constants. If, then, the various processes of nature to which these molecules have been subjected since the world began have not been able in all that time to produce any appreciable difference between the constants of one molecule and those of another, we are forced to conclude that it is not to the operation of any of these processes that the uniformity of the constants is due. The formation of a molecule is therefore an event not belonging to that order of nature under which we live. It is an operation of a kind which is not, so far as we are aware, going on on earth or in the sun or the stars, either now or since these bodies began to be formed. It must be referred to the epoch, not of the formation of the earth or of the solar system, but of the establishment of the existing order of nature, and till not only these worlds and systems, but the very order of nature itself is dissolved, we have no reason to expect the occurrence of any operation of a similar kind. In the present state of science, therefore, we have strong reason for believing that in a molecule, or if not in a molecule in one of its component atoms, we have something which has existed either from eternity or at least

from times anterior to the existing order of nature. But besides this atom, there are immense numbers of other atoms of the same kind, and the constants of each of these atoms are incapable of adjustment by any process now in action. Each is physically independent of all the others."

The meaning of this is perfectly clear; in the last quarter of the last century, less than fifty years ago, it was the doctrine of science that the so-called elements were absolutely distinct each from the other, and more, that they had been so from the beginning. Further, it was held that in no way could one of them become transmuted into another.

All this view of nature was upset by the discovery of radium and the establishment of the Disintegration Theory of Radioactivity by Rutherford and Soddy, occurrences which practically belong to the present century.

By this time everyone who reads the daily paper can hardly fail to be aware of the fact that Radium pours out energy; slowly no doubt and perhaps fortunately so, for the quiet pursuance of life on the earth, for it has been estimated that if all the energy contained in fifteen grains of radium could be suddenly developed it would suffice to blow the entire British Navy a mile into the air. But energy is developed and with that development there must be a change in the element; in other words, a transmutation. As a matter of fact, this is what is now known to happen in the case of Radium and some similar radioactive substances. It is a lengthy process in comparison with our puny lives, for it takes two thousand years for radium itself to fall to half-value; but that is, of course, a brief period when considered in relation to the age of the world. But even Radium is not the first stage in the process of development; for, from what we know of the age of the world, it has been stated that if the entire globe, at the beginning of time, had consisted of nothing but Radium, the amount now left in existence would have been quite insignificant. This predecessor of Radium seems to have been an element known as Uranium, from which is formed Ionium, a substance very slow in transmutation since it is asserted that whereas Radium, as we have learnt, takes only two thousand

years to fall to half-value, Ionium requires two hundred thousand. Radium itself passes through various stages until, it would appear, it completes its history by becoming lead. The transmutation, then, of one so-called element into another is actually an event which is slowly taking place every day in the laboratory of nature. No present-day alchemist has yet discovered how to effect that transmutation in his laboratory : he can only watch its progress.

But since it does take place it is clearly not impossible that science may yet solve the question of how to effect the transmutation, or, perhaps more properly should it be said, to "speed it up" so that the slow processes of nature may be replaced by the rapid transformations of the chemist.

At any rate, apart from the theories which have been all too briefly touched upon in this and the preceding chapter, we may allow the thought to sink into our minds that what science firmly held some fifty years ago she has now discarded in favour of a totally opposite group of theories. It is a lesson which we shall learn from the history of other scientific theories; and it may at least teach us, as it has begun to teach the men of science of to-day, that caution and even scepticism must be exercised in face of all theories of the past, the present, and the future.

CHAPTER VIII

FACTS AND THEORIES ONCE MORE

THE lesson alluded to in the closing words of the last chapter is one which should be carefully considered, and a few of the matters of chief importance which have been touched upon may here be recapitulated and expanded.

In the first place, then, an effort has been made to explain the very real and all-important difference which exists between a fact and a theory. That there is such a substance as gold, for example, is a fact if there are any realities external to ourselves. That it cannot be transmuted by any means at present known to science into anything but gold is a fact, so far as our present knowledge goes, but it may not always remain a fact. It is, therefore, less certain than the fact that there is such a thing as gold. But, as we have seen, it was also set down as a fact, and that within our own lifetime, that gold and all the other so-called elements were all of them *ab initio* and unalterably distinct from one another and wholly incapable of being transmuted into anything else but what they were. The lesson we learn from all this is that it is not always easy to be quite certain as to what is and what is not a fact. There are a vast number of facts as to which no doubt can exist. Either no knowledge of any kind is possible, or it is a fact that man has an osseous vertebral column, and so on. There are also a large number of opinions, such as the Electrical Theory of Matter which we have just been discussing, which are admittedly theories subject to discussion and finally to confirmation or disproof. It is true that we may find many a theory definitely set down as established by enthusiastic writers in the daily press which is not so regarded by those who are really entitled to speak on the subject.

Unfortunately the "man in the street" usually learns of these things from his newspaper and not from the scientific expert, and is thus led to assume a certitude for such theories which admittedly they do not possess, and which is in no way claimed for them by those responsible for their formulation.

Further, no one can have failed to notice that as soon as even the most tentatively enunciated theory is put forward it is at once claimed as the last final and crushing blow to the pretensions of religion, if in any conceivable way it can appear to militate against belief. The age of superstition is over—the absurd ideas of our fathers are shown to be obsolete—there is no God, no future life, no anything: all because someone has very cautiously and very tentatively ventured to suggest that such and such an explanation of such and such a physical or biological fact may possibly be true. In all probability the theoriser was not thinking about religion when he built his theory, and it is more than likely that the theory in no way—even if true—bears out the construction which has been put upon it, and ultimately one or both of these facts emerges. But by this time the populariser, without whom the "man in the street" would never have heard of the theory in question, has gone his way. He has got his little bit of "copy"; he has had his congenial little fling at religion; he is hunting some totally different hare, and his readers hear no more of the theory and its developments. In all fairness it must be admitted that another result usually follows. The fly skilfully thrown seldom fails to "rise" some ecclesiastical fish. Unwarned by or ignorant of the history of these things he rushes into print, often with a very imperfect knowledge of the theory and what it involves, and thus succeeds in one thing only and that is in persuading the "man in the street" that things are really looking black for religion. This is very far from saying that the time does not sometimes arise when a definite word must and should be said, but what is deprecated is the hasty acceptance of newspaper accounts of theories with the deductions therefrom made by the journalist. Readers of the preceding pages at least will not require to be warned against the too ready acceptance of theories, nor will they

need to be reminded that the theory loudly acclaimed to-day may find itself on the scrap-heap to-morrow. Such has been the history of many a theory in the past and no one doubts that such will be the history of many another in the future.

But there is a further matter to be borne in mind, and it is this :—However imperfect some of these hypotheses have now turned out to be, they were nevertheless invaluable as working hypotheses from the time they were formulated and still are of the utmost value to science, and this because each of them was an approximation to the truth or what now seems to us as likely to be the truth. Thus what were known as elements, though not really "elementary" in the sense which used to attach to that word, are nevertheless, so far as our present knowledge goes, unalterable by any means that the chemist can bring to bear upon them in his laboratory. So also the Atom, though it is no longer to be regarded as the ultimate particle of matter, is none the less a real thing from the chemist's point of view, and the Atomic Theory, as has already been pointed out, is just as indispensable to the chemist as it has been from the time of its formulation. The same may be said about the Molecule. Moreover, the same is true in other matters which have not so far been touched upon. Thus, for example, what is meant by Energy and by the term The Law of the Conservation of Energy ? As to the latter, something will have to be said in a later chapter, so we may leave it for the present. Energy as used by the physicist is a generalisation, and in order to make the law alluded to true, quite a number of things have to be included under the term. "Things as distinct from each other as light, heat, sound, rotation, vibration, elastic strain, gravitative separation, electric currents, and chemical affinity, have all to be generalised under the same heading [the conservation of energy] in order to make the law true. Until 'heat' was included in the list of energies, the statement could not be made ; and a short time ago it was sometimes discussed whether 'life' should or should not be included in the category of energy. I should give the answer decidedly No, but some might be inclined to say Yes ; and this is

sufficient as an example to show that the categories of energy are not necessarily exhausted ; that new forms may be discovered ; and that if new forms exist, until they are discovered, the law of conservation of energy as now stated may in some cases be strictly untrue ; just as it would be untrue, though partially and usefully true, in the theory of machines, if heat were unknown or ignored."[1] "Partially and usefully true," that is the point which we must keep before our minds, that a theory, though it is only part of the truth and therefore false as a complete explanation, may yet be permanently valuable as a partial expression of actual facts.

Further, so it would appear from the statements of leaders in physical science, it is quite possible that if we had grasped the significance of the law at the commencement, it might never have been understood in its full completeness, or even that if conceived in all its complexity it might never have been formulated ; nor ever have been accepted. On these points I must again make reference to the writings of Sir Oliver Lodge, which are of especial interest because his constant endeavour is to present his readers with the general or philosophical bearings of his subject, and not merely to acquaint them with the dry bones of science, as too many do in this age of over-specialisation. After alluding to the fact that it is the complexity of the laws which our more exact knowledge of facts has brought to our notice which is largely responsible for the scientific scepticism which has already been alluded to, he continues : "The simple laws on which we used to be working were thus simple and discoverable because the full complexity of existence was tempered to our ken by the roughness of our means of observation. Kepler's laws are not accurately true, and if he had had before him all the data now available he could hardly have discovered them. A planet does not really move in an ellipse but in a kind of hypocycloid, and not accurately in that either. So it is also with Boyle's law and the other simple laws in physical chemistry. Even Van der Waal's generalisation of Boyle's

[1] Lodge, "Life and Matter," London, Williams & Norgate, ed. 2, 1905, p. 21.

law is only a further approximation. In most parts of physics simplicity has sooner or later to give place to complexity: though certainly I urge that the simple laws were true, and are still true, as far as they go, their inaccuracy being only detected by further real discovery. The reason they are departed from becomes known to us; the law is not really disobeyed, but is modified through the action of a known additional cause. Hence it is all in the direction of progress." And he quotes from Poincaré on the same point: "Take, for instance, the laws of reflection. Fresnel established them by a simple and attractive theory which experiment seemed to confirm. Subsequently, more accurate researches have shown that this verification was but approximate; traces of elliptic polarisation were detected elsewhere. But it is owing to the first approximation that the cause of these anomalies was found, in the existence of a transition layer; and all the essentials of Fresnel's theory have remained. We cannot help reflecting that all these relations would never have been noted if there had been doubt in the first place as to the complexity of the objects they connect. Long ago it was said: If Tycho had had instruments ten times as precise, we would never have had a Kepler or a Newton, or Astronomy. It is a misfortune for a science to be born too late, when the means of observation have become too perfect. That is what is happening at this moment with respect to physical chemistry: the founders are hampered in their general grasp by third and fourth decimal places; happily they are men of robust faith. As we get to know the properties of matter better we see that continuity reigns."

It would thus appear that there are other reasons—besides that general one that we must usually proceed step by step—why it is even beneficial to science that its discoveries should be made bit by bit. But it is certainly also a lesson against proclaiming that we are at the end of our journey when we may not yet have even come in sight of the penultimate peak.

Those who take the trouble to pursue their studies in this book to the end will scarcely fail to see that the greater part of the argument which it presents is based on what

has been said up to the present, for the really important thing to get into men's heads—difficult as the task seems—is that there is all the difference in the world between a Fact and a Theory, and more especially all the difference in the world when we come to consider their respective bearings upon the dogmas of religion. Consequently a certain amount of repetition has been ventured upon in this chapter in the hope that a restatement of certain of the points previously dwelt upon may perhaps bring them more clearly before the mind of some reader of these pages, and for the same reason and again risking the accusation of "vain repetition," a brief summary of these points may now be given.

1. When we talk about a Fact we must be quite sure that what we are talking about is a fact and not a mere theory.

Let us take a homely example to explain once more what is meant by this. "I hear A.B. has just been married to C.D."—"Is that a fact?"—"Oh, yes, there can be no doubt about it, for I was at the wedding myself and saw the ceremony and was a witness to the signatures." That certainly may be accepted as a fact which cannot be disputed or cavilled at. But suppose the conversation continues: "I hear he married C.D. out of pique and because E.F. refused him."—"Is that a fact?"—"Oh well! everybody says that was the reason for what otherwise seemed inexplicable." That is not a fact at all, but what we should commonly call a bit of gossip. In a word, it is a theory. It may be a theory founded on an established fact or facts. For example: E.F. may have very unkindly made it widely known that she had refused the offer of A.B., and further C.D. may have been the kind of woman unlikely to attract either by charm of person or manner, and unprovided with the goods of this world which sometimes seem to make up for a total lack of other attractions. Under these circumstances the gossip or theory in question may seem quite probable and yet, as we all know very well, it may be wholly incorrect. No one really could clear up the matter but A.B. himself, and it may be taken as unlikely that he will do so. Certainly no man, not even the

most experienced of psychologists, can take upon himself to explain why certain persons attract certain other persons, and it is consequently impossible to say that A.B. has not imagined that he has found or actually has found in C.D. charms quite unsuspected by the outer world yet all-sufficient for himself. This homely parable will, it is hoped, make the point clear. A provable fact is a fact, but a theory is a theory, and may never rise to the position or value of an established fact.

2. There are things which seem to be established facts and which yet may not be so, such as the old idea respecting the Chemical Elements. Now let us bear this in mind: such possibly controvertible facts—if that term may be employed for a moment—are "facts" of a comprehensive nature which have passed from the category of hypotheses into that of facts. Single isolated facts but rarely suffer such a fate. No doubt Bathybius did, but such facts as these:—man has a backbone; gold is heavier than aluminium; the whale is a mammal, and so on—cannot be controverted.

But the idea of the Chemical Elements, which is a comprehensive fact—if fact at all—based upon a number of subsidiary facts and observations, began life as a theory and won such wide acceptance that it came to be looked upon as a fact and taught as such, though all the time it was very largely, though, as we have seen, not completely, false and unfounded.

3. We must not forget that the inaccurate or imperfectly accurate theory may have been exceedingly useful in its time either in explaining matters better than they had previously been explained, or in promoting work along lines hitherto unpursued and yet exceedingly fruitful. When we discuss the theory of Natural Selection in later chapters of this book we shall learn that but few look upon it nowadays as more than a very partial explanation of the process of evolution, though some years ago it held a much stronger position than that. Yet no one will dispute the fact that it has made some at least of the operations of nature clearer, if only by the criticism which it has provoked; and that in any case it has stimulated enquiries which have led to the

vast enrichment of our knowledge of biological facts. Further—and this is certainly a quite unsuspected conclusion—it seems to be clear that the early imperfection of a theory is actually necessary to its ultimate and complete comprehension, and that its complete unfolding when first discovered would, paradoxical as it may seem, interfere with its capacity for being grasped and utilised by the men of science of the day.

4. Such being the case, the Catholic can look with complete religious unconcern on all disputes as to theory, however much his scientific interest may be awakened by them. Facts, incontrovertible facts, have not really conflict with religious questions, and only a false attitude towards the Bible can cause them to appear to do so. It can hardly be supposed, to refer to an instance quoted above, that anyone would be upset if he read in the Bible or in the works of some justly venerated Father of the Church, that the whale was "a great fish," when he knows very well that fish it is not. He knows, or he ought to know, that the word is used in a popular manner and in a way with which we are very familiar ourselves. No one would feel the slightest sensation of surprise if on any Friday in the year he found himself sitting down to a "fish-dinner" on the menu of which appeared lobsters and oysters, neither of which are fish, nor even anatomically as near fish, as the whale. Similarly, "the sun stood still," like our "the sun rises," is a popular method of speaking, and involves the fact that in some way or another—and various ways have been suggested—God Almighty did prolong the hours of light in the case of Joshua; certainly does not necessarily involve inferences which churchmen of the time of Galileo unwisely read into the statement. They, as we have seen, were men of their own time and not in front of it, and they fell into the errors natural to what figured in those days as science. But we should be careful to make use of the better guidance which we have obtained in such utterances as the "Providentissimus Deus" and avoid the mistakes which we can see our predecessors have made and which, indeed, it would have been exceedingly difficult for them to have avoided. On the

other hand, our belief in God and in Revelation assures us that any *theory* which appears to conflict with either will only do so in appearance, or will turn out, in so far as it does so conflict, to have been inaccurate.

5. As regards the various facts and theories which we have been considering in the preceding pages, it is obvious to anyone considering them, in the most superficial manner, that they in no way come into even apparent conflict with any of the doctrines of the Catholic Church. Whether everything that has been said respecting the Ether and the Electrical Theory of Matter be proved truth or utter misconception, matters, from the point of view of religion, not one single atom. We have to get further along the pathways of science before we begin to find even the shadow of religious contradiction.

What at least we may learn is this: that the incomprehensible and inscrutable wonders of which so slight a sketch has been given must, on the purely materialistic explanation of things, have all come about by blind chance: and we ask ourselves in all seriousness whether that is the kind of explanation which a reasonable man can possibly accept. There was a time, not so long ago, when people used to be told, not perhaps by the wisest of men, that they should not believe anything which they could not understand, and that as they could not understand God they could not be expected to believe in Him. Here, perhaps, it may be parenthetically enquired, what kind of a God would that be whom His creatures could understand? But let that pass. We are now asked by serious men of science to believe in an entity, like the Ether, which is full of all sorts of apparent difficulties and even contradictions. We are told that it is impossible to believe in God because He could not be at once absolutely just and all-merciful and omnipotent and tolerate evil. Yet we must believe in the Ether which is uncompressible, denser than anything which we can conceive and yet through which anything can pass without friction. This analogy is not mentioned for the purpose of raising difficulties about the Ether but merely to point out that if there are difficult mysteries in religion there are mysteries of science in their own way certainly not less

difficult to believe. Yet there are those who look upon us as weak-minded if we ignore or explain the difficulties of religion, and yet regard us as impertinent if we refuse our credence, implicit and instant, to the teaching of the science of to-day. There seems to be a little unfairness in this distinction.

CHAPTER IX

MATTER AND FORM

THE Church makes but one statement as to the origin of the universe and of this world, which is a very small part thereof: "God created them." Beyond this she does not go, and as was said in the previous chapter, science and religion are on wholly distinct and not even adjacent paths so far as concerns the subjects with which we have been dealing hitherto.

Ninety-nine per cent of the teachings of science are of no consequence to religion as such. This is the case with practically all the teachings of Chemistry and Physics. As to the remaining one per cent of the teachings, they too, if properly looked at, also have nothing really to do with religion.

It is, however, otherwise with Philosophy, which has a burning interest of its own in the matters so far under discussion. To this aspect of the question we must now turn our attention, devoting some little space to a brief consideration of the extraordinarily interesting and extraordinarily difficult question of the Scholastic Doctrine of Matter and Form. This can only be touched upon in these pages so far as to indicate to readers the outlines of the theory and its relations to some of the more recent views of men of science as to the nature of Matter.[1]

[1] It is almost impossible to grasp the full significance of the theory in question without longer study than can be afforded to it by others than professed philosophers and theologians. Those who desire to make further acquaintance with it than is possible in the few pages which can here be devoted to it, may commence by studying the following articles in the "Catholic Encyclopædia": "Matter"—"Form"—"Cosmology" and other articles mentioned under those headings. They may then

The very first thing which is necessary, in approaching the Scholastic idea of Matter and Form, is to get rid of all preconceived ideas respecting both of these words, and especially all ideas such as those which have been under consideration in previous chapters. Matter, as we commonly talk of it and as we have been considering it, is a real entity—" Matter " in the Scholastic sense is rather a metaphysical entity than a real physical one, since it can have and has no existence by itself and apart from Form. The Matter of the physicists is a thing which in its various manifestations we can see and handle, the other is a thing which we cannot see or handle because it cannot exist by itself. Let us see how this is. It is clear from our own everyday observations that Matter—as commonly understood—presents to us a double series of manifestations—" it is not only *active*, but *passive;* not only *one* in its nature, but *manifold* in its extended parts; not only *special* in its own nature, but *generically common* in all natures; furthermore, it changes from one nature to another, and that by way of *transformation*, not of simple *substitution*, for there is something common to it before and after the change."[1] Thus we are led to believe that Matter, as commonly conceived, is not single but dual in its constitution. It is held by this theory that there are two opposite principles required. The first of these is *Primordial Matter*, the " Matter " of the Scholastic. Speaking in common terms, we may think of this as the indispensable basis of all things. It cannot exist by itself, and we cannot represent it to ourselves any more than we can represent to ourselves substantial form which is its accompaniment. But we can conceive of each of them. " For St. Thomas, primordial matter is the common ground of substantial change, the element of indetermination in corporeal beings. It is a pure potentiality or determinability, void of substantiality, of quality, of quantity, and of all the other accidents that

proceed to consolidate their knowledge by studying Fr. John Rickaby's " General Metaphysics " in the Stonyhurst Series. They will then be in a position, should they so desire, to make a really serious study of the question in the pages of the learned " Cosmologie " of Professor Nys, of Louvain, or in those of Fr. Harper's " Metaphysics of the School."

[1] Rickaby, *op. cit.*, p. 86.

determine sensible being. It is not created, neither is it creatable, but rather concreatable and concreated with Form, to which it is opposed as a correlate, as one of the essential 'intrinsic constituents' of those corporeal beings in whose existence the act of creation terminates. Similarly it is not generated, neither does it corrupt in substantial change, since all generation and corruption is a transition in which one substance becomes another, and consequently can only take place in changes of composite subjects. It is produced out of nothing and can only cease to be by falling back into nothingness. Its potentiality is not a property superadded to its essence, for it is a potentiality towards substantial being."[1]

Form, on the other hand, is the intrinsic determinant of anything that is determinable. Form comes and goes, while the matter with which it co-exists remains as the principle of unity. "While forms come and go, matter is the same throughout, not being liable to 'corruption and generation.'"[2] After these formal definitions it may be simpler to put matters in this way. There is a common "matter" which cannot exist by itself but is always associated with "form." This common "matter" is the same in gold and in lead, in the rose and in the rabbit. It is in the *materia prima* or prothyle. "Form" is the correlative matter which makes the gold gold and not lead, the rose a rose and not a rabbit. This is the "substantial form." We cannot see it by itself, any more than we can see "matter" by itself: it is the combination which is evident to our senses.

Further, the "form" may change though the matter remains. Thus the rose may and certainly will decay and cease to be anything which we could call or think of as a rose. Its "matter" remains, though its "form" has changed; the form of a rose having disappeared and that of a number of other things having taken its place.

Many volumes have been written on this subject, far exceeding in number the total of the pages which can here be devoted to it. Hence many—perhaps most—of the points

[1] "Catholic Encyclopædia," *sub voce* "Matter."
[2] Rickaby, *ut supra*.

of interest and controversy must be passed over undiscussed, nor can any attention be paid to other schools of thought on the subject. But the following matters must not be passed over.

The kind of "form" may be different, apart from the differences which lead to such different manifestations of matter with form as—say—lead or gold. Gold, for example, is equivalent to *materia prima* plus a corporeal and ultimate form which is inseparable from it. This is a corporeal substantial form. A rabbit is *materia prima* with a form also, but a form of a higher order. In the Aristotelian and Scholastic view the form in a living animal is the vital principle or actuating energy which unifies and dominates the material factor constituting with it a living being of a definite kind. They deemed it incapable of subsisting apart from the body, but called it an "animal soul."[1]

Finally, in the common teaching of the Schoolmen, man is *materia prima* with a form, but again a form of a totally different and still higher order. The "form" of man is his rational soul, and that is a Spiritual or "separated" form, for it can exist apart from the body which it normally actuates and for which, as the Schoolmen believed, it retained a certain aptitude or disposition even when separated at death. On the other hand, the "form" of the rabbit disappears with the death of the animal.[2]

[1] It will be noticed by those familiar with his work, of which more will be said in a later chapter, that Driesch, in his theory of the "entelechy," has returned to and fully accepted this position, though, of course, in no sense a follower of the Schoolmen.

[2] Though this difficult matter cannot be discussed here with any fullness, the following points may be added: The "form" of a plant or animal is not a *spiritual* or *subsistent* "form." Spiritual, according to the scholastics, means capable of acting and subsisting apart from matter. They deemed the angels purely spiritual or "subsisting" forms—*Formæ subsistentes*—naturally existing altogether apart from matter. This the human soul does not, for it retains an aptitude or inclination for its partner. Also some Schoolmen—the Scotists generally—held that the human soul did not *immediately* and *directly* inform the *materia prima*; that between them there were intermediate subsidiary forms or stages of actuation, and they used their theory ingeniously to explain the growth of the hair, nails, etc., after death by the survival or succession of other forms. The conception has difficulties but is a very useful one for the neo-scholastic who has to meet the difficulty of the sort of subsidiary life and individuality assigned to the cell by modern biology. This is more difficult to harmonize with the doctrine of the soul immediately and directly informing pure *materia prima*.

Of course no attempt can here be made to submit any proof of these doctrines, nor even to outline the reasons for them. All that has been attempted is to sketch them out so that their bearing on what has gone before may be estimated, and, it may be added, a foundation laid for what has to be said in subsequent chapters.

Now let us turn to the physical idea of Matter. According to the idea sketched out in Chapter vii, the ether is the underlying element of all matter and is always the same. The various forms of matter presented to our senses are modifications of that ether or common substructure. They are, as Sir Oliver Lodge puts it, "like knots in a piece of string." As all sailors know, there are a variety of knots, any one of which can be made in a piece of string and again unmade. The piece of string remains the same, though its appearance may have been completely modified and again modified and remodified by the various knots into which it has been twisted. In all of this there is a certain resemblance between the two theories, since we may equate *materia prima* with the ether and "form" with the kink or knot which it assumes in any given body. Yet there is a profound difference between the two in this respect. Matter according to most of the scholastics, and certainly according to Aristotle himself, is nothing of itself. Aristotle said that it has "neither quiddity, nor quantity, nor quality, nor any of the determinants of Being."[1] Ether, on the other hand, has very marked characters, as we have seen. It is an entity, if it exists at all, and not an abstraction like *materia prima*. Hence according to the pure scholastic doctrine it would have its own "form" and so be a particular kind of *materia secunda* or ordinary matter, and we should have to get behind that etheric form to arrive at the true *materia prima*. In this connection it must not be forgotten that some of the scholastics have argued that *materia prima* has a sort of incomplete entity of its own, which would bring us at least within measurable distance of the physical idea of the ether as the basis of all matter.

There are at least two important points to be borne in

[1] Rickaby, *ut supra*.

mind before we pass away from a subject which has been all too briefly treated.

In the first place, it will readily be agreed that the theory of Matter and Form, as thus sketched out, does approximate to the modern idea of matter far more than it does to the doctrines of chemistry and physics commonly taught up to yesterday.

As long as it was held that there were eighty or more manifestations of matter, all utterly and *ab initio* different from one another—*fundamentally* different—the scholastic doctrine could find no common ground for discussion with the rigid supporters of such a doctrine. It is not now denied that metaphysical chemists may all the time have admitted the existence of a *materia prima;* what is being discussed now is the commonly accepted idea. Now, however, that chemists, and still more physicists, are more or less agreed upon the ether as the basis of material objects, it is clear that we have arrived at a point not far distant from the conception of the Scholastics. This, at least, may be said: that the conception which has held from the time of Aristotle up to the time of Boyle is nearer modern scientific ideas than the conception ordinarily held by chemists until within the last few years and from the days of the Alchemists.

The other point which Catholics should carefully bear in mind is this: Religion does not stand or fall by the Scholastic Philosophy, as many of the opponents of the Church try to make out. The Scholastic Philosophy, as pointed out in Chapter iv, is the traditional philosophy of the Catholic Church. The Church has utilised its terminology and nomenclature in the definition of her dogmas. She has employed the conceptions of the Scholastic Philosophy in the exposition and explanation of these dogmas; its principles and arguments in their systematisation and justification. In fact, the old philosophy of the great Greek pagans was adopted by the theological thinkers of the Middle Ages and developed into an instrument of marvellous elasticity, subtilty and precision for organising, unfolding and harmonising with reason the whole content of doctrine contained in the Christian Revela-

tion with its logical implications. As a consequence, the technical theology of the Church and the authoritative enunciation of her dogmas have become so thoroughly incorporated in the language of the Scholastic Philosophy, and so long and so familiarly illustrated by the metaphysical concepts of that system of thought that it is pretty certain her teaching will never be divorced from that philosophy or united with any other. Indeed every attempt to present important doctrines, such as that of the Eucharist, in the framework of other metaphysical systems has usually completely failed. Still it must never be imagined that the Catholic Church is bound to stand or fall with the Scholastic Philosophy. It existed and spread and taught the world for a thousand years before that philosophy was heard of. Its doctrinal teaching is on a different plane and guaranteed by a different authority from the most unanimously accepted theses and speculations of the schools.

Neither the metaphysics of Aristotle nor its scholastic development is any part of the revealed deposit of Faith. Even at the zenith of his glory no accredited Catholic theologian taught that Aristotle was inspired—at any rate by the Holy Ghost. Nay, the great Theological Faculty of the University of Paris in the thirteenth century solemnly condemned him as a most dangerous enemy of the Christian Faith, and several of his works were for a long time actually on the Roman Index. Nevertheless, all this being borne in mind, the historical fact remains that the Catholic Church has approved the Scholastic Philosophy as she has done none other; she has adopted it officially in her schools, and she has again and again commended St. Thomas, the greatest Master and Doctor of the Scholastic Philosophy, to all her students throughout the world. And now, when we turn to consider the trend of the most recent philosophico-scientific speculation, we find that most important doctrines of the Schoolmen which had been treated with the greatest contempt by modern science—the science that is of but yesterday—and never more so than in the nineteenth century, prove to be the opposite of the absurd things which a temporary attitude of science would have made them out to be.

In the case of Matter and Form, we have a far-reaching theory which had been held by all the Schoolmen, indeed by all learned men for centuries. It conflicts with a novel theory of science adopted with that ardour with which we are prone to accept new doctrines of science—the Theory of the Chemical Elements. As it conflicts with that Theory, the Theory of "Matter and Form" is not only neglected but assumed to have been disposed of for ever and to have become a laughing-stock and a patent evidence of the foolishness of Catholic Philosophers.

"Turn, Fortune, turn thy wheel and lower the proud." The day arrives when Science changes her mind as to the Theory of the Chemical Elements and lo! it becomes evident to all who take the trouble to study the subject, that the new standpoint of Science, if not identical with that of Scholasticism, is at least so close to it as to be indistinguishable save by the expert; and even by him admitted as being whole regions closer to it than the view in favour until recently. It is not now argued that this proves the Scholastic view to be unassailable, but it at least shows that it is worthy of serious and respectful attention.

When a Theory—a philosophical theory—shows itself adaptable to the newest discoveries of science—when, still more, it may be looked upon without any straining of facts as having actually predicted those discoveries, or preconceived them, if that word is to be preferred—then indeed we have every reason to feel that our confidence in the accuracy of that theory is greatly increased, and it is increased by the remarkable similarity which has been seen to exist between the theory of "Matter and Form" and the Electrical Theory of Matter as now widely taught.

NOTE TO CHAPTER IX.—It is so exceedingly important for any person desirous of grasping much of what appears in the earlier chapters of this book to comprehend the essentials at least of the Theory of Matter and Form, that I append another statement of the various "forms" which has been placed at my disposal by a learned friend, and which may throw additional light on the question as dealt with in this chapter.

As to "forms": There are (1) *accidental forms*, i.e. determinations or qualifications of a being which make it such-and-such but do not constitute its essence, e.g. colour, size, etc. Some

of these may be specific determinants or inseparable properties of an entity, e.g. yellowness of gold, or the invariable concomitants of a zoological species.

There are (2) *substantial forms*, which constitute the actual concrete existent substances or are the physical actualities which make a being be what it is, which, in fact, make it a unitary entity (e.g. a rabbit).

There are various gradations of substantial forms. To adopt one simple scheme we may classify them thus:

(1) Mineral or inorganic (e.g. gold).—It is generally held that this lowest kind of form is extended, i.e. related in a one-to-one mode with space. Thus the form of a lump of gold can be subdivided by breaking the lump. Or we might take the molecule to have the substantial form, the lump being merely an accidental congeries of substantial forms.

(2) Plant-form (or soul).—Here we have a higher unity than in (1). We might almost say that we have the beginning of a conquest over space. The plant is more than a mere collection of inorganic chemicals. It is an organic unity. It is *one* in a sense in which its spatial parts are not one. The functional unity of a plant argues an ontological unity—as yet, however, imperfect.

(3) Sensitive or animal form (or soul).—Here we have a still higher unity—the unity of sense-consciousness. It is unthinkable that the percept (e.g. landscape) should be correlated by a one-to-one process with the percipient's brain. In the end the percept must be perceived as a whole. (Even K in consciousness is not the sum of I and $<$.) Hence it is absurd to seek the sensitive soul among brain-cells—the soul is the synthesis of them all; it is present in each and in all. It has a mode of presentiality of its own. The evidence for the morphological and physiological unity of an animal also shows that we must adopt the concept of such an entity.

(4) Spiritual or intellectual form (or soul).—Of this the only instance is man. Man not only perceives but conceives. Only to man have things a *meaning*. It is true that every concept is accompanied by a percept (and so probably by a physiological change). But this accompaniment is accidental, i.e. it influences only the process, not the object. Even to think of God we must see or pronounce His name or some name. Both reason and free-will postulate a soul which is not only simple and unextended (as is the animal soul) but also spiritual, i.e. a soul whose existence (esse) is independent of matter. In a word the human soul not only "informs" (actualises) the human body, but (as it were) has something left over after so doing. As the Schoolmen put it, it is "not wholly immersed in matter."

CHAPTER X

THE UNIVERSE

IT is a mere platitude to say that a large book might be written about the Universe—a library of books—and yet the subject would in no way be exhausted. In the brief space which can be allotted to it here, all that can be attempted is to give some sort of idea of what is meant by the term; of the immensity of the subject dealt with; of what has been suggested as to the origin, proximate and ultimate, of the Universe.

In Chapter iii the controversy usually associated with the name of Galileo was outlined, and it was then pointed out that, at his time, there were two views as to the solar system, that corner of the visible universe best known to us. There was the geocentric system which made the earth the centre of all things, and the heliocentric which made the planets of our system circle around the sun as their centre. The latter was the theory of Copernicus and Galileo, and is that which everybody now accepts. When it was put forward, this explanation, as we have seen, was only a likely solution of the difficulty. It was not till Copernicus had been some two hundred years in his grave that Bradley (in 1726) discovered the aberration of light, and converted, what had up to then been a more or less probable theory, into an incontrovertible fact.

We may commence with the solar system, comparatively small though it is, and work upward from it towards the immensities of the Universe. Now our solar system consists of what we call "the" sun, though it is only one of many such bodies. Our sun forms the centre of a system of planets thus arranged:

Mercury, is the nearest to the sun and has no satellite.

Venus, also without a satellite.
The Earth, with one satellite, the Moon.
Mars, with two satellites.
A zone of minor planets or asteroids.
Jupiter, with seven satellites.
Saturn, with ten satellites.
Uranus, with four satellites.
Neptune, with one satellite.

When we come to ask the distances which intervene between these members of the solar system, and still more between the solar system and others of the visible bodies in the universe, we slowly begin to realise that we enter a realm of numerical relations utterly unlike anything which we are otherwise acquainted with—a realm having units otherwise unknown and only imperfectly realisable after long and careful thought has been bestowed upon them.

To begin with, the association of numbers known as a million miles is to the Universe something like what an inch is to our ordinary maximum measurements. Yet it is not easy to grasp what is meant by a million, even in these days when we read of that figure in connection with the vast armies of the Continent of Europe or as the cost of some enormous ship of war. The late A. R. Wallace had a scheme for supplying every important public school with a room in which the walls and ceiling were covered with one million black wafers, the object of the whole being to habituate the mind of the child to the meaning of the word and to make him understand what is meant in pounds or dollars of taxation and national expenditure.[1] Perhaps it may assist the imagination of the reader if he is told that all the *words* in the present book amount to something considerably less than one-fifth of a million : it is possible that the *letters* in it may reach the larger total.

At any rate, it is with figures of this size that astronomy and astronomical calculations have to do, and we must try to understand what they have to teach us. Let us still confine ourselves to our own solar system. In the measurements of this system the million sinks to the place of an

[1] "Man's Place in the Universe," London, Chapman & Hall, 1904, p. 82.

inch and we have to seek for another unit which we may find in the distance of the earth from the sun, i.e. 92,830,000 miles. Utilising this unit we can arrange the solar system thus :—

The Sun.	
Mercury . . .	$\frac{4}{10}$ of a unit.
Venus . a little more than	$\frac{7}{10}$ of a unit.
Earth	1 unit, i.e. 92,830,000 miles.
Mars	$1\frac{1}{2}$ unit.
Jupiter . .. . over	5 units.
Saturn	$9\frac{1}{2}$ units.
Uranus	19 units.
Neptune . . .	30 units.

So that to obtain the distance from the Sun to Neptune it is necessary to multiply 92,830,000 miles by 30 : when the reader has done that and allowed the figures to sink into his mind, he has next to learn that, comparatively speaking, they are quite trivial in relation to other measurements which have been made between the various observable objects in the visible universe. In order to study these we have to abandon even the huge unit with which we have been dealing and find another in order that our figures may become at all manageable. To do this we must turn to the question of light. Light, as we have already learnt, travels at an absolutely definite and unalterable rate of 186,000 miles per second—thus it takes eight minutes to come from the Sun to the earth. Some idea of its rapidity may be formed if we consider that an untiring and everlasting express train which never required to stop for repairs, coal or water, but went on and on at the even rate of sixty miles per hour, would require 175 years to traverse that awful gap. Or, to take a smaller distance, a beam of light could do the double journey from London to New York and from New York to London about thirty times in one second.

Let us leave that point for one moment to grasp the fact that our sun is only one of many such objects in the universe. How many such there may be it is hard to say, since each improvement in astronomical apparatus reveals more and more to the trained observer. Whether the enormous telescope of Mount Wilson, with its five foot reflector, is to

remain the largest thing of the kind time will tell; but at any rate the mammoth telescope and, above all, the improvements in celestial photography have greatly extended our knowledge of the heavenly bodies.

As a recent writer[1] puts it: "Unlike the eye, the photographic plate never tires, and the longer it is exposed, provided the telescope can be pointed exactly at the same celestial object,[2] the more it sees. The action of light upon the silver salts on the plate is in such cases cumulative, and hence after exposures of nine or ten or more hours the plate when developed will show structure in a nebula, which the eye could never have grasped even when aided with the most powerful optical power as yet available."

Up to the present time the result of all these unwearied observations has been to show that there are something like 100,000,000 stars, that is to say suns, visible to the astronomer by one or other of his methods. Thus our star, the Sun, which seems, and indeed is, so important to us, is only one out of an almost inconceivable multitude of suns in the visible universe.

The nearest neighbouring sun to our system is the star known as Alpha Centauri, as to the distance of which from us the following facts may give some idea. We return to the question of light and its rate of transmission. Light, travelling at the rate of 186,000 miles per second, takes

Eight *minutes* to come from the Sun (92,830,000 miles).
Four *hours* to come from Neptune, the most distant planet of our system.
Four and a half *years* to come from Alpha Centauri, the nearest neighbouring sun to our system.

Here we are introduced to a new unit—that of the "light-year," which is the distance travelled by a beam of light in the course of one year. Thus Sirius, the "Dog-Star," the brightest of what are called the fixed stars, is nearly nine light-years distant. Any reader of this book can now perform

[1] Fr. Cortie, S.J., "The Origin of the Sun and Stars," in "The Month," January, 1914. To this article and another on "The System of the Stars," published in "The Month" for March, 1912, I am indebted for a number of the facts given in this and the immediately succeeding chapters.

[2] As, of course, it can be for any desired length of time with the aid of modern machinery.

a long but simple sum in multiplication in order to afford himself some idea of what a "light-year" really means. Let him first of all multiply 186,000 by 60 in order to arrive at the number of miles per minute. He will find it comes to quite a respectable total. But this again has to be multiplied by 60 to account for the miles per hour, and that sum by 24 so that we may know how many per day. Finally, the enormous line of figures now arrived at has to be multiplied by 365 to make up the sum total for a "light-year." Now if he chooses to do so, he can multiply this by four and a half and he will have arrived at the distance which separates us from the nearest sun not that of our own particular solar system.

But that is the *nearest* sun, and there are millions further off. For example, let any reader who is approaching his fortieth birthday make up his mind on the evening of that day, if the condition of the sky permits him to do so, to look at the North or Pole Star. If he does so he may bear in mind that the beam of light which has that moment caught his eye started on its mad race of 186,000 miles per second on the day when he first saw the light of earth. But this is a mere trifle, if it be true, as Kapteyn, a recent writer, maintains, that there are stars in the visible universe which are as much as 30,000 "light-years" off.

It is quite impossible for anyone, even after long meditation on the subject, thoroughly to appreciate what all this really means; but a couple of illustrations of the subject may now be set down in the hope that they may in some measure enable the reader to comprehend something of the awful distances of the visible universe. One of the most recent manuals dealing with the subject[1] says: "Many have tried to find some way of picturing the distances which separate star from star in the sun's neighbourhood. Perhaps there is no way better than to imagine a model in which the sun is represented by a grain of sand one hundredth of an inch in diameter"—(the actual diameter of the sun being 864,000 miles)—"and the earth"—(actual diameter at equator 7926 miles)—"by a quite invisible speck one inch away"—(actual distance of the earth from the sun

[1] Hinks, "Astronomy," Home University Library, p. 169.

92,830,000 miles). " Upon this scale the nearest star will be another grain of sand some four miles away, and the other stars will be scattered at somewhat greater distances apart. To this incredible sparseness are the stars reduced when we try to look at them in three dimensions."

Or let us look at it in another way.[1]

Everybody knows that maps are drawn to certain scales. There is in this country a six-inch scale, i.e. six inches of map represent one mile of land. That is a large scale and enables every small road and other details to be delineated, but it is too large a scale for ordinary use. The one-inch is the standard ordnance map, and every mile of ground is there represented by one inch of paper. That again is far too large a scale to be used for great countries. For instance, I have just been looking at a map in a school atlas, which represents the United States on the scale of 250 miles to the inch, making about eleven inches from San Francisco to a point on the eastern coast. Two hundred and fifty miles of land represented by one inch of paper: it is about as small a scale as is compatible with usefulness. Now, suppose we were to try to plot out the visible universe to scale on paper, what scale could we employ? As a matter of fact we should find the thing quite impossible on any scale, but let us suppose that we adopted a scale of one-million-millionth of an inch to the mile, or, in similar terms to those used above, one mile of space represented by one-million-millionth of an inch, how large a map should we require? We should need a strip of paper two miles and three-quarters in length to work upon. We may well say that the task is an impossible one.

Observe that what we have so far been discussing refers only to the visible universe. In that universe our solar system is only a very small item. The planets which comprise it are whirling round the sun, their centre, as we all know; but they and the sun are also constantly rushing through space towards the constellation known as Hercules at the rate of twelve and a half miles per second, a comparatively moderate rate in comparison with what we have

[1] Suggested to me by my friend Professor Conran who has made the calculation.

recently been considering, yet one which makes up quite a respectable total for a year—to take it no further—if we make the calculation. Hence the members of our solar system are constantly altering their positions, as a whole, with regard to the visible universe. Can we form any conception of where we are in respect to its other portions, or what the general contour of that universe may be?

In attempting to answer these questions, we must first direct our attention to that well-known object in the heavens, the Milky Way. This object is a ring of clouds of stars which lies in the central plane of the whole system of stars. As we approach this ring it is found that the stars have a greater density, and that this increase in density is progressively carried on from the poles of the Milky Way to its circumference. This, and other facts which cannot here be dealt with, "lead to the conception of the universe of stars as flattened into a lenticular form, our sun occupying a position in the median plane and not far removed from its centre. Ptolemy placed the earth at the centre of the planetary system, modern astronomers give it a far more dignified position as near the centre of the whole congeries of stars."[1] Much was made of this point and of the unique possibilities of this earth as a place of habitation for men by the late A. R. Wallace in his book "Man's Place in the Universe." As to this it may be said that, as far as we know, with the single possible exception of Mars, life for men, constituted as men on this earth are constituted, or indeed life of any kind recognisable by us as life, would not be possible upon any other planet of our system—perhaps, though this is a large assumption, not anywhere else in the visible universe. This is, of course, very far from saying that there may not be other forms of existence of which we can form no notion on other planets, or indeed in other parts of the vast universe on which we have been bestowing so cursory a consideration.

Of course we cannot really comprehend all these immensities: they terrify the mind which tries to take them in. Mr. Hardy's astronomer in "Two on a Tower," says: "There is a size at which dignity begins; further on there

[1] Cortie, "System of Stars," *ut supra*, p. 248.

is a size at which grandeur begins; further on a size at which awfulness begins; further on a size at which ghastliness begins. That size faintly approaches the size of the stellar universe." And then, with that pessimism which is characteristic of his more thoughtful characters, the author makes his hero add: "Am I not right in saying that those minds who exert their imaginative powers to bury themselves in the depths of that universe merely strain their faculties to obtain a new horror?"

So far we have only thought of the visible universe, but what are we to say about Space, which in one of its corners, so to speak, contains this vast visible universe. Space presents itself to us as represented by our possible or actual forms of motion. Thus we can walk forwards or backwards or from side to side, and we can jump into the air or down into a hole. That is to say, we have experience of a three-dimensional state of things and we refer this experience to what we call space. But we actually know of Infusorians which only move backwards and forwards and which would, therefore, had they any ideas, only have an idea of a two-dimensional space. We can certainly conceive a one-dimensional space, and the mathematicians claim to show us that it may be possible to conceive of space of four or even more dimensions with results completely subversive of all our ideas regarding material objects. This territory is, however, confessedly misty and obscure.[1] Unconsciously no doubt in most cases, but none the less really, we think, so far as we do think at all, of Space on the lines indicated, that is as three-dimensional. Of course, the vast majority of people never trouble to think what is really meant by Space—or by Time either, for the matter of that, a subject whose problems are closely associated with those of space. These are metaphysical problems, and it must be the task of the metaphysician to endeavour to explain to us what reality outside our own minds corresponds to those two terms "Space" and "Time." Most people who think about such things at all no doubt envisage the problem, as many writers have done, as one of an objective

[1] On this point see a very interesting article in "Mathematical Essays," by Schubert (Trans. McCormack), "Open Court," Chicago, 1898.

nature. They think of space, as we may think of the ocean, an infinitely vaster ocean but still a sort of ocean with the Ether instead of water, an ocean in which the stars and other heavenly bodies revolve and move. That, however, s a very inadequate manner of considering the problem, for it leaves out of account the boundless potential regions beyond the area, however vast, of space actually occupied by existing material creations. We cannot think of an ocean without thinking of its shores, the shores of Europe or America or Asia or whatever they may be; but Space, looked at objectively, has no boundaries.[1] Immense and awful as are the distances involved in our visible universe, there is no valid reason why there might not be a million, even a million million such universes in illimitable space. Hence the ocean simile breaks down in connection with Space, just as the river simile breaks down in connection with Time, of which Newton spoke as something which "in itself and from its nature flows equally." But the flowing thing must have a beginning and an end, not to speak of boundaries, none of which things can we predicate concerning Time.

The opposite way of looking at it is the subjective, by which Space and Time are explained as real only to our minds. The high-water mark of this method may be found in the transcendental ideas of Kant, who taught that Space and Time are conditions of all our experience, not gained from it; that is, that they are *a priori* ideas supplied by the mind from its own resources. They are attached to things-as-we-know-them or Phenomena, not to the *ding-an-sich*, the thing-in-itself. Kant described these two ideas by saying that Space is the form of outer sense, Time of inner sense. Now in the case of Space this extreme view breaks down. Astronomy and astro-physics assume an objective space of three dimensions corresponding to our conception of it, and are unintelligible in any theory which denies the external validity of that

[1] We must always bear in mind, in dealing with these topics, that there is only one *ens reale vel actuale*—one Infinite Reality, namely God. Similarly there never can be actualised an *infinite* number. On the other hand, possibilities of all sorts are infinite, but they are *entia rationis*, with a foundation in God's omnipotence.

conception. There is a *via media.* If Space is not an independent entity or real thing-in-itself and yet is not purely subjective—since it is relative to our sensuous powers of perception, and since our spatial perceptions and conceptions do enable us to deal successfully with objects—it is clear that the objective universe has an arrangement which corresponds in some way to what we call spatial arrangement, even though we may be unable to explain what that may be.

Of course, the plain fact is that we can neither perfectly nor adequately conceive what is meant by Space any more than we can feel that we have a full comprehension of the Universe. Yet there are persons who admit all these facts and limitations; who credit all that is told them about the Universe and its composition; who admit that they can form no idea of what is meant by Space, though they agree that it is there: but who yet refuse to believe in God because they cannot understand Him, or understand how He can never have had any beginning nor will ever have any end. Of course, it is no argument to say that because we have one thing which we cannot understand we may try to explain it by something else which we do not fully comprehend. To that we may agree and on this point we base no argument on behalf of the existence of God. But what we may fairly claim is this: the contented acceptance of one problem, admitted by materialists to be incomprehensible, does take away from them the right to use that most foolish argument, which one used to hear so often and still hears from time to time, that we ought not to believe anything which we cannot understand. It is absurd to suppose that we ought to be able to understand God: He would not be God if we could.

But we may gain a useful lesson in spiritual humility by making a meditation on Space and Time, when we shall be bound to come to the conclusion that we can form only the feeblest and most inadequate conception of what is meant by these terms, and recognize that the mind is in no way capable of defining or explaining them. Yet in a sense they are only the outskirts of the One Eternal Being who created the Universe and all that it contains.

Perhaps to one who views man as a mere cog in a gigantic machine, or a speck in an ocean of dust, the impression most forcibly brought before the mind may be their ghastliness, when he ponders on such things as Space, the Universe, the inconceivable distances which it involves, the immense areas of space empty, so far as we can tell, of everything but the Ether.

But in the mind of the believer in a Creator the idea would be dispelled, even were it ever to be formed, by the thought of the gloriousness of the whole conception, its majesty, its incomprehensibility, its fitness, so far as anything is fit, to serve, as the half-visible garment of that Being whose greatness and attributes we can only represent to ourselves by the incomplete and ineffective figures which are all that are possible to our finite minds.[1]

[1] For Kant two things are " sublime " : the starry heavens above and the moral law within. Similarly, St. Ignatius Loyola, who loved to meditate on the sky: his favourite exclamation was, " Quam sordet tellus quando cœlum aspicio ! " [How mean the earth seems when I look at the heavens !]

CHAPTER XI

THE ORIGIN OF THE UNIVERSE

THE topics discussed in the last chapter have been included in this book with a dual object. In the first place it is important that the immensity and difficulty of the problems connected with our conception of the Universe and the fundamental character of considerations relating to Space and Time should be realised by those who have not previously been brought in contact with them.

Such considerations, when rightly meditated upon, form no inconsiderable part of the argument for the existence of a Supreme Being, which will be dealt with in the next chapter.

Again, the subject of the present chapter, which is of importance from quite another point of view, would have been unintelligible without the preliminary statements considered in the immediately preceding pages.

So far then we have discovered that the theory of scientific men is that the Space of the entire physical universe—whatever arrangement of things that may really mean—is occupied by the Ether which is the continuum by which action at a distance, otherwise inexplicable, is explained.

Further, that the visible universe consists of a vast collection of stars and other bodies ; that this collection taken generally is lenticular in shape and that it has our Earth somewhere about its centre.

We have now to see what theories have been put forward to account for this arrangement of the universe and we may commence with the best known and most widely held which is called the Nebular Theory or Hypothesis.

The telescope reveals to us a large number of what are called nebulæ, though only two of these are even faintly visible to the naked eye, the least invisible being that which can be seen in the sword-handle of the constellation of Orion. Subject to the further explanation which has yet to be given, it may be said that a nebula, as indeed its name indicates, is a kind of cloud—an incandescent cloud emitting a more or less faint light, which retains its relative position to the other heavenly bodies. In this respect, as in others, a nebula differs from a comet, with which it must not be confused. A comet is not in permanent relation of position, so far as we can tell, to any other heavenly bodies, nor do we know whether comets "are really indigenous to the solar system or whether they may not be merely imported into the system from the depths of space."[1] When we come to ask what is the nature or structure or composition of nebulæ we are told that in some cases at least they can be shown by very high-powered telescopes to be made up of an innumerable multitude of small stars. In other cases no telescope constructed up to the present has been able to resolve the nebula in such a manner, and so far as our knowledge goes such nebulæ would seem to consist of an incandescent gas. That nebulæ are incandescent is clear; and this is a point of great importance in connection with a matter to be dealt with in a subsequent chapter. They emit a light of their own, white in most cases but of a bluish green in those of the planetary and irregular varieties. We do not as yet know how these nebulæ are kept in a state of incandescence. According to the hypothesis put forward by Sir Norman Lockyer, the light is to be attributed "to collisions between numbers of small discrete solid particles, these being vaporised and made luminous owing to the heat developed by their impacts."[2]

By calling in the aid of the spectroscope we are able to tell something about the composition of these nebulæ, as we are about that of the stars themselves. For the sake of those who are unfamiliar with the nature of the spectro-

[1] "Encyclopædia Britannica," ed. xi, *sub voce* "Nebular Theory."
[2] "Encyclopædia Britannica," *sub voce* "Nebula."

scope it may be said at once that what it tells us about in the case of the star is the character of its thin outer envelope and not strictly speaking the character of the star itself.[1]

In spite of this limitation it is conceded that the spectroscopic method does afford us information of incalculable value as to the composition of the heavenly bodies. As far as regards the stars we learn that their chemical composition is very similar to that of our sun, and that the sun itself presents a range of chemical components similar to those of which our Earth is made up. Owing to the very feeble light which they emit, the spectra of nebulæ are very difficult of observation: still many of them have been spectroscopically examined, and the result has been to show that most of them reveal by their spectra a chemical composition indistinguishable from that of the stars. Some, however, whilst presenting in their spectra lines familiar to us and recognisable as those of elements with which we are well acquainted, also present other lines which have so far not been recognised as related to any elements existing on this earth.[2] These two unknown lines are always found together, have always the same relative intensity and have been attributed to an unknown element which has been called "nebulium." With this apparent but perhaps not

[1] Any manual of spectroscopy will explain the instrument and make clear the point just alluded to, which cannot here be further dealt with. For a brief but admirable account of this and other matters referred to in this chapter the reader may be directed to "The Making of the Earth," by J. W. Gregory, Home University Library.

[2] It is quite possible that we are not acquainted with all the elements which exist in the earth itself. The interior of the earth, which from its weight is called the barysphere, must be much heavier than the crust or lithosphere. This last is only two and a half times as heavy as an equal bulk of water, whilst the entire globe is five and a half times that weight. There are facts which point to the conclusion that the barysphere is composed of nickel-iron, but the truth is that we do not know and are never likely to know what it consists of. This matter is mentioned in order to show that the fact that the lines of nebulium have not as yet been associated with anything on this earth does not prove that there is nothing in the earth which is associated with them.

Apropos of this matter it may be mentioned that helium, as indeed its name implies, was first discovered in the sun, as long ago as 1868, by means of its characteristic bright yellow spectrum-line. It was only in 1895 that it was identified in this earth, when Sir William Ramsay found it in certain minerals. It has since become famous as the constituent of the "alpha-rays" of radio-active substances.

real exception, the spectroscope teaches us that we may look upon stars, nebulæ, and our own solar system as consisting of the same chemical substances. If they are identical in character, may they not be also identical in origin? Is not that the simplest and most satisfying solution of the question as to how the universe comes to be as it is? This identity of composition is indeed one of the most important arguments in favour of the Nebular Hypothesis.

As put forward originally by Laplace, this theory supposed that the position now occupied by our solar system—to confine ourselves to the consideration of that which we know most about—was once occupied by a vast, perhaps lenticular nebula, the centre of which occupied the position now filled by our sun.

This nebula was in a condition of incandescence and was, therefore, emitting light. Further, it had a rotatory movement and was whirling round at a rapid rate on its own axis. We may pause for one moment to remember that the theory postulates, but does not account for, the nebula, its incandescence, and its motion.

What follows explains, or may explain, what happens in such a system, but it neither explains nor pretends to explain the system itself. To return to the theory. This heated, whirling nebula would by slow degrees become cooler, and as it became cooler it must contract towards its centre. Further, the more it contracted the more rapidly it must have rotated. All these things follow upon what we know as the laws of nature and need not be delayed over. In such a system as this there must be two conflicting forces. First of all there is the centrifugal force, which tends to tear the periphery from the centre, the kind of force which we see in action when a mop full of water is "trundled." Secondly, there is the force of attraction, which holds the periphery to the centre. Now as the contraction and the rapidity of rotation of the system increase, the time must come when the centrifugal force at the periphery must overcome the attractive force towards the centre. Any person who thinks for a moment will see that the result of this must be the splitting off of the periphery of the nebula as a

kind of ring. A repetition of the events thus described, followed by still further repetitions of this process of splitting, would lead to the formation, first of all, of a second ring within the first, and then of other such concentric rings, all of which would have been formed from the original nebula. In the centre or focus would be what remained of the nebula after the successive rings had been split off it. And, just as the original nebula was whirling round in a certain direction, so the nucleus and the rings which had split off it would continue whirling round in the same direction as the original nebula and, therefore, in the same direction as each other. Let us now return to the rings which we have supposed to have been split off and consider what their fate may have been. In either case, in the process of cooling, the rings must have passed from the state of an incandescent gas to one of a liquid character before they could settle down as solids.[1] If, in this process, consolidation were to take place with something like uniformity, a great number of small planets would be formed. This is actually what we find in the interval between the orbits of Mars and Jupiter (see Chapter x). The more likely condition seems to have been one of non-uniform consolidation, for the ring is not likely often to have been quite uniform in all its circumference. But, if it were not thus uniform, it would consolidate more rapidly in one part than it would in others, with the result that a single planet would be formed. Further, just as the planets, under this theory, have split off from the mass which ultimately remains as the sun, so the satellites, such as our moon, have in a secondary manner split off from the various rings or spheres. Primary or secondary in their manner of splitting off, all these bodies, being parts of the original nebula, would retain their motion and the direction of that motion which the nebula itself possessed. As a matter of fact, of

[1] From the point of view of this book it is merely necessary to show that the Nebular Hypothesis, if true, does not in any way conflict with religious opinions. At the same time, for the sake of accuracy, it may be noted that a ring of matter can only concentrate around its centre and this would mean that the ring would return to its parent nucleus. Hence it is better to regard the detached portions as initially more or less globular rather than ring-shaped.

course this is what we find to be the case in regard to the sun and the planets, including our earth :—

> "This world was once a fluid haze of light
> Till towards the centre set the starry tides,
> And eddied into suns, that wheeling cast
> The planets."

Thus the poet sums up, not inaptly, the Nebular Hypothesis as generally received. Fascinating as it is we must remember that it is only a hypothesis and one which may—almost certainly must—receive profound modification. For example, the lenticular mass of vapour which Laplace posited may very probably have to be abandoned in favour of the spiral or corkscrew form, which has been shown to characterise so many nebulæ. It is also questionable whether any nebula is hot enough to be incandescent. In fact some think that nebulæ are cold, with the intense cold of space, and that their luminosity is due to a rain of electrons. That they are luminous is, of course, undoubted.

This, however, may be said, that the views which have just been briefly sketched afford a very complete explanation of the facts of the solar system, and, being free from inconsistency with at least most known facts, have long been accepted as at least a very useful working hypothesis. In connection with it let us look for a moment at the problem of the continuance of the radiation of its heat by the sun, on which matter a few moments may now profitably be spent. In the first place, let us consider the enormous output of energy of which the sun is agent. The noontide heat which falls upon this county of Cork, in which I am now writing, would be more than sufficient to drive all the steam engines of the world. Yet the whole earth only receives one 2,200,000,000th of the sun's radiance. The sun's radiated energy amounts to about 14,000 horse-power per square foot of the solar surface. Every one has heard or read the statement that our coal fields are "bottled sunlight," for the energy which we obtain from the combustion of coal is only that which was gathered from the sun by the forests of the Carboniferous Period and stored up for our use. If it be true, as seems undoubtedly to be the case, that this bottled energy will be exhausted within

a measurable period of time, it is clear that the best hope for the future is that science will discover some method of harnessing the sunlight itself in and for the service of mankind. It is clear that this vast amount of radiation must be explicable in some way or another: what is that way and what the explanation?

The first explanation that would occur to anyone is that the radiation is due to a simple process of cooling down. This, however, is an impossible explanation. Had radiation been due to a cooling process, then, at the rate at which it is going, the sun would have cooled very appreciably even during historic times, which is not the case. In fact, if the sun's specific heat were that of the substances composing the great bulk of the earth, the annual fall in its temperature would be nearly 10° F.

This explanation having proved to be faulty we may turn to the next simplest: the sun is a fire, i.e. in a state of combustion. This also is untenable. The sun is, in fact, above the temperature at which we believe chemical combination to be possible. But, even if the sun had been a solid mass of the best Kilkenny anthracite, burning swiftly enough to produce the known heat-supply, less than 6000 years would have been required for its complete consumption.

These two simple explanations having utterly failed we may turn to another which would not suggest itself to the ordinary thinker, namely, the so-called Meteoric Hypothesis.

We know that if we hammer a piece of iron it will become very hot and we can understand from that, what is also true, viz. that the impact of a cannon-ball upon a sheet of armour-plate engenders great heat. In the same way a fall of comets or meteorites or cosmical matter into the sun might, it has been suggested, keep up its incandescence. To this explanation also there are insuperable objections. In the first place, the sun's mass would by this means be increased by an annual layer of twenty metres of asteroids. This would produce very remarkable effects, amongst which this may be mentioned, that since the dawn of the Christian era the year would have been shortened

by six weeks. Further, if the sun were thus a target for such a battery, so also must the earth be, though necessarily to a feebler degree. Nevertheless, if such were the case, calculation shows that, on this theory, each square mile of the earth's surface would be bombarded by fifty tons of missiles every day.

The only theory, in fact, which holds the field is that of Helmholtz, namely, the theory of Gravitational Shrinkage. Just as a stone on a height, or an avalanche, or a stream, can do work and generate heat by its descent to earth, so the contraction of the sun's materials can convert their previously existing potential energy into kinetic energy and so into heat. Further, it must not be forgotten that gravity on the sun's surface is twenty-eight times what it is on earth.

If we assume the sun to be of uniform density in its interior and that it contracts uniformly, the contraction necessary to generate an energy equal to that radiated is about 225 feet a year, or four and a half miles in a century. This would amount to about a second of arc in 10,000 years, so that we can hardly hope as yet to obtain direct evidence for the contraction. Of course, if the sun's radiance is due to progressive shrinking, it is clear that a time existed when it was much larger and more diffuse than it is now, which in itself supports the nebular hypothesis. "It has been estimated," says the writer in the last edition of the "Encyclopædia Britannica,"[1] "that the sun is at present contracting, so that its diameter diminishes ten metres every century; there is, however, now reason to think that the rate of contraction is by no means so rapid as this would indicate. This is an inappreciable distance when compared with the diameter of the sun, which is nearly a million of miles, but the significance for our present purpose depends upon the fact that this contraction is always taking place. Assuming the accuracy of the estimate just made, we see that a thousand years ago the sun must have had a diameter a hundred metres greater than at present; ten thousand years ago that diameter must have been one thousand metres more than it is now, and so on. We cannot, perhaps, assert

[1] 1910–11.

that the same rate is to be continued for very many centuries, but it is plain that the further we look back into the past time the greater must the sun have been. Dealing, then, simply with the laws of nature as we know them, we can see no limit to the increasing size of the sun as we look back. We must conceive a time when the sun was swollen to such an extent that it filled up the entire space girdled by the orbit of Mercury. Earlier still the sun must have reached to the Earth. Earlier still the sun must have reached to where Neptune now revolves on the confines of our system, but the mass of the sun could not undergo an expansion so prodigious without being made vastly more rarefied than at present, and hence we are led by this mode of reasoning to the conception of the primæval nebula from which our system has originated."[1]

Laplace's theory, with which we have been dealing up to now, postulates the original nebula as gaseous in its composition—gaseous and luminous. It may now be well to deal very briefly with another theory which differs somewhat from that already under consideration, and in this way. According to Laplace's view, as we have seen, the planets in the course of their formation pass through the stage of being each of them in a gaseous ring. According to the Meteoric Theory the nebula consists not of an incandescent gas, which may afterwards cool down first into a liquid and then into a solid, but of a huge collection of solid meteorites. Everybody has seen a "shooting star." Each of these is a solid meteorite which enters our atmosphere cold and dark; which there, by friction, becomes heated and luminous for the short time which generally intervenes before it is reduced to powder and becomes a trail of incandescent dust. The collection of solid meteorites above spoken of, whirling round as the nebula whirls, must come into constant collision with one another and thus develop heat and incandes-

[1] It is only fair to add that the exploits of radium have lately thrown some doubt on this theory. The presence of about 3½ grams in each cubic metre of the sun's mass would be sufficient to account for the present radiation. But it must be confessed that up to the present moment there is absolutely no evidence entitling us to assume the existence of solar radium.

cence.[1] It is possible that the collection of solid meteorites may have first of all been a nebula composed of incandescent gas but broken up into meteorites not contracted into a planet.

There is this to be said about this theory, that it seems to explain the ancient climates of the earth better than the other. In the most ancient times, long ages before man was there to make observations, and when life was only beginning its first struggles with its environment, we should have expected to find that on account of the greater heat of the crust of the earth climates and climatic conditions were very different from what they are now. It may well be asked how we can possibly know anything about them. Well, the surfaces of some of these ancient plains of the archæozoic era have actually been preserved for us under blown sand, which has formed sandstone, and this when removed has exposed the ancient land-surface to our observation. With this result : that we know that the prevalent wind in Scotland, for example, was then, as it is now, from the south-west, that the raindrops were of the same size and fell with the same force as to-day, in a word, that there was no very material difference between the conditions millions of years ago and to-day. It is urged that all this concurs better with the meteoritic or planetesimal theory than with that of Laplace, and it is certain that the earth which has unquestionably been hotter than it is, would take a shorter time to cool down from the condition of a group of consolidated meteorites, heated by mutual collisions, than it would have done in cooling down from the condition of an incandescent gas, or a superheated liquid. The fact is that there are difficulties of various kinds, some of them mathematical in their nature, in connection with either explanation, but the facts seem to point to some such theory as that with which we have been concerning ourselves, eventually emerging as the accepted explanation of the condition of the solar system. It need hardly be said that neither of these theories is a complete

[1] Of course, some of these meteors do actually reach the earth ; far more than is generally imagined. See "The Making of the Earth," pp. 33 *seq.*

or final explanation, and that neither of them in any way conflicts with any dogma of religion, which insists on only one point, that "in the beginning God created the heaven and the earth." How He chose to do this is only indicated in outline, and in no way contradicts or raises any difficulty in connection with the nebular hypothesis or its variants.

CHAPTER XII

THE ORIGIN OF THE UNIVERSE—*continued*

SO far as we have gone we have under our consideration: Space, whatever that may really be; Luminiferous Ether, whatever again that may be; Heavenly Bodies of various kinds, some of them incandescent gas, some of them superheated molten masses; some of them, like our Earth, warm; some of them, like our Moon, cold extinct masses. We have all these various forms of Matter and we have all this Matter in Motion. We can form some idea of how this may have come about, given Matter and that in Motion. Can we form any idea of how Matter and Matter in Motion first came into existence, that being the underlying fact of the scheme of the Universe?

There are, as we shall see, two and two only explanations possible. They must be considered separately, and will be discussed in this chapter. But before attacking them a word must be said as to another attitude towards this question common enough to-day and perhaps still more common some twenty-five years ago.

It is the attitude which Huxley named Agnosticism, and from the rigidly scientific point of view it is a perfectly reasonable attitude. Du Bois Reymond, one of Johannes Müller's most brilliant pupils, laid it down that there were Seven Enigmas confronting the scientific enquirer which were:—

(i.) The nature of Matter and Force.
(ii.) The origin of Motion.
(iii.) The origin of Life.
(iv.) The apparently designed order of Nature.
(v.) The origin of sensation and consciousness.
(vi.) The origin of rational thought and speech.
(vii.) Free-will.

The first, second, and fifth of these he described as "transcendental" and insoluble—*ignoramus et ignorabimus.* He thought that the same would probably have to be said about the seventh. As to the others, they were probably solvable, but were still unsolved. Now with regard to this attitude it may rightly be said that science cannot solve any of the great fundamental questions, though science can supply any number of invaluable facts which at any rate enable philosophy to offer some explanation of these fundamental matters. The Agnostic attitude has sometimes been rather severely criticised, but surely if a man of science keeps within his own territory it is better for him honestly to confess that he does not know than to spin the scientific cobwebs of explanation which we come across in the writings of Haeckel and of Weismann, explanations avowedly invented lest we should accept that Christian explanation which still holds the field for so many who do not even claim to be called Theists.

Let us turn from the attitude of pure Agnosticism as to the origin of Matter and Motion, to the explanations of those phenomena of which, as we have said, there are in the last analysis only two, for we arrive here at what logicians call a Dichotomy.

Either Matter was created or it is self-existing, and further, it must be alive.[1] If we sift out the meaning of Pantheism, the Anima Mundi and conceptions of that kind; if we apply ourselves to the consideration of Bergson's Creative Evolution,—his blind deity ever impelling matter onward to an unknown goal,—all these conceptions really resolve themselves into that of Matter, alive and eternal. To this conclusion came the authors of "The Unseen Universe"; indeed, it is the conclusion to which all who

[1] St. Thomas discusses the possibility of a creation from all eternity. Aristotle had held the eternity of the world, or at least of matter, in some sense. St. Thomas teaches (by reason) that motion cannot be eternal and that, consequently, a world with any change in it cannot be eternal. He holds, however, that reason cannot disprove the possibility of the creation by God from all eternity of some sort of matter with no motion in or attached to it. No motion, for motion originates time. Of course, he teaches that according to Christian Revelation neither the Angelic nor the Material Universe was created from Eternity. In any case, matter or any finite or imperfect reality could not be *self-existing*. The self-existing must be perfect, infinite and, therefore, one or unique.

consider the question must come.[1] These men had made a very special study of matter and their fame is likely long to survive. Their object was to show that the materialistic views, rampant and apparently victorious all along the line at the time that the book was published, i.e. in the early seventies, were no solution of the difficulties which they purported to explain. In the preface to the second edition, which also appears in later editions, the authors say: "To reduce matters to order, we may confidently assert that the only reasonable and defensible alternative to our hypothesis (or, at least, something similar to it) is the stupendous pair of assumptions that visible matter is *eternal*, and that IT IS ALIVE." And they continue: "If anyone can be found to uphold notions like these (from a scientific point of view), we shall be most happy to enter the lists with him." Yet Haeckel's so-called Law of Substance—unaccepted by any physicists so far as the present writer is aware—practically amounts to the very thing which these two eminent physicists ridicule, that Matter is eternal and alive. In fact, so it must be, twist the explanation how one will, unless it was created and is directed. In the body of their book the authors consider this question of the living atom, and though opinions as to the position and character of the atom have undergone a considerable change since the book was written, such changes of opinion have rather tended to confirm than to weaken the views which are now about to be quoted. The materialists or pantheists, or whatever we may choose to call those who contend for a living and eternal atom, as against one which has come into existence at the fiat of the Creator, maintain that the atom—or, perhaps it would now be said, the electron—is the true abode of immortal life in the universe and that its life is a very simple one. Such in a condensed form is the attitude. In reply the authors of the book we are considering ask what all this may imply. "It implies, in the first

[1] The authors of "The Unseen Universe," at first issued anonymously, were Professors Balfour Stewart and P. G. Tait, two of the most distinguished physicists of their day. This book has undeservedly rather passed out of mind but it is well worth reading. The quotations given here are taken from the 7th ed. published in 1878 and the italics and capitals are those of the authors themselves.

place, that the atom is eternal, and to this we object. It implies, in the next place, that the atom is extremely simple in its constitution, and to this we object." It may be said that modern views decidedly support both these objections, and more especially the second of them. Then they proceed: "It implies, thirdly, that for the antecedents of the motions of the atom it is unnecessary to resort to anything beyond the atom itself, and to this we object." In connection with this last objection they claim "that in order to conceive the nature of the forces by which atoms act upon each other we are driven at once . . . to something which implies the existence and the agency of the Unseen Universe." Finally, "We maintain that *what we are driven to is not an under-life resident in the atom, but rather*, to adopt the words of a recent writer, *a Divine over-life in which we live and move and have our being*."[1]

Here, then, we see science brought to the brink of the question as regards matter, is it created or is it eternally self-existing and alive? The two physicists in question declare that it is not eternal and not alive. Either, then, we must admit that it was created and that there is a Creator, or we must content ourselves by saying "*Ignoramus et ignorabimus*," with Du Bois Reymond. Our authors do not hesitate to accept the former alternative and to proclaim their belief in a Creator of the Universe. The same conclusion was arrived at by one who was an even more distinguished physicist than either of the two just mentioned, distinguished as they were. Lord Kelvin can hardly be said to have had a superior or even an equal save Newton alone, and Lord Kelvin declared in an address to the Students of University College, London, in 1903, that Science positively affirms creative power.[2]

Let us now, however, turn our attention to the Universe as a whole. Have we any reason to suppose that it has always been as it is, or that it will always remain as it is? On the contrary, we have every reason to believe that it is

[1] *Op. cit.*, pp. 241 *seq.* Italics as in original.

[2] "I cannot admit that, with regard to the origin of life, science neither affirms nor denies creative power. Science positively affirms creative power . . . which [she] compels us to accept as an article of belief" ("Nineteenth Century," June, 1903).

in a constant state of flux. There is no doubt in anyone's mind that the earth was once a mass of exceedingly hot, if not absolutely molten, material and that it has gradually cooled down to the condition in which we now know it. If the nebular theory is true there was an even earlier period when it was a glowing gas, or something nearly as attenuated. Not long ago it was thought that it would gradually cool down, until, like the moon, it became a cold, dead world, a "has-been" of the skies, incapable of supporting life of any kind, or at least anything which we could now recognise as life.

Nowadays some hold a different view, believing that the temperature of the earth is slowly but certainly rising and that it will continue to rise until it reaches the bursting point, when it will explode and blow into atoms, becoming "cosmic dust" or a mass of fragments which might conceivably be consolidated into a new planet or become a group of asteroids.[1] What, for our purposes, is important about these theories is that they show that it is not expected that the world will go on for ever as it now is. The Universe, as we know it, must have an end, and we may fairly claim that it must have had a beginning for reasons that will yet appear. Of course, the reply may be made that this is true of the Universe, *as we know it*, that it must have had a beginning and will have an end, but that this is true only in a certain sense. In other words, it may be argued that this world was once no doubt a molten mass; we know that it is now inhabitable, which it cannot have been for long ages of time; we can well believe that there will be an end to it as it is now; all this may be accepted. But what is there to prove that it will not be reconstructed in the manner suggested from a group of planetesimals formed by the disruption of the earth into a new planet, perhaps in time itself to become the fruitful mother of life? This is Haeckel's argument in relation to his "theory of substance." Thus it has been stated that the nebular theory confirms the view that the cosmogonic process has not simply taken place

[1] Incidentally it may be remarked that these theories need not cause any alarm since in neither case is the end dated for less than several million years ahead.

once but is periodically repeated. That whilst in some parts of the universe new cosmic bodies arise and develop out of rotating masses of nebulæ; in other parts old, extinct, frigid suns come into collision, and are once more reduced by the heat generated to the condition of nebulæ. Now, in the first place, it may be remarked with regard to this theory, that whether probable or not matters but little from our present point of view, since it does not help us to solve the question as to who made the machine, wound it up and set it going. We are still reduced to the matter-alive theory which we have seen is rejected by the physicists whose speciality matter is. But apart from that there is a serious difficulty in the way of this phœnix-like production of new worlds from old, and that difficulty lies in the undoubted fact of the degradation of energy. The question of the Law of the Conservation of Energy will have to be considered more fully when we come to close quarters with the Vitalistic controversy, but for the moment we may say that it teaches that in a closed system there is a certain amount of energy capable of manifesting itself in various ways but remaining the same in amount through all its changes of character. It appears, for example, as heat, as motion, as strain, and so on, but the amount does not differ: the sum adds up the same at the end whatever the factors may be. Now, as far as we are concerned, the universe is our closed system. The solar system is not, for there is radiation from it into space, which radiation means dissipation of energy. Of course there is an enormous amount of energy in the solar system, not to speak of the universe, but we must not forget that a great deal of this might as well not be there for all practical purposes, because it is unavailable, that is, incapable of transformations. All the activities of actual matter, as we know it, are accompanied by a degradation of energy, i.e. there is less available at the end of the process than there was at the beginning. Thus every stroke of a steam-engine means a transference of heat from a hotter to a cooler body; hence at the end we are left with two bodies whose temperatures are closer than at the start. We may regard the universe as a steam-engine—but without any outside supplies of fuel. Every

change, every motion, brings nearer the day when all its portions will have been reduced to the same dead level of temperature. Heat is the final stable form of all these energies, and every exercise of power pays a toll to that great reservoir of uniformly distributed heat which is slowly but surely ushering in "the night when no man can work."

Thus, to turn to our own universe and the earth upon which we have our temporary habitat, the rotation of the earth round the sun and of the moon round the earth cause tides in the sea and in the atmosphere around the earth, which tides produce friction. It is known that the period of the rotation of the earth is gradually growing greater and it can be calculated that the time will come when the earth will rotate on its own axis in the same period as it rotates round the sun, that is, in a year. In other words, the year and the day will coincide. Under these circumstances the kinetic, or we may here call it actual and available energy of the earth, will be less than it now is. How are we to account for the balance? It has become friction of the tides against the earth, and this friction has been transformed into low-temperature heat, and that again has been radiated into space and has become non-available. And so with steam and internal-combustion engines, and in fact all exhibitions of energy there is a certain loss of available energy or degradation thereof.

Now let us apply this knowledge to the theory that the universe is cyclically renewing itself in the manner indicated above. The whole question is fully considered in a recent book from which we may quote.[1] The author in question points out that our closed system is the universe, which from the physical point of view we must look upon as finite, for if infinite all our speculations become meaningless, and he continues: "The universe therefore is a system in which energy tends continually towards degradation. In every process that occurs in it—that is to say, every purely physical process—heat is evolved, and this heat is distributed by conduction and radiation, and tends to become uni-

[1] Johnstone, "The Philosophy of Biology," Camb. Univ. Press, 1914, p. 63.

versally diffused throughout all its parts. When this ultimate, uniform distribution of energy will have been attained all physical phenomena will have ceased. It is useless to argue that universal phenomena are cyclical. We vainly invoke the speculations (founded on rather prematurely developed cosmical physics) of stellar collisions, light-radiation pressure, the distribution of cosmic dust, etc., to support our notions of alternate phases of dissipation and concentration of energy; close analysis will show that all these processes must be irreversible. The picture physics exhibits to us is that of the universe as a clock running down; of an ultimate extinction of all becoming; an universal physical death. In this conclusion there is nothing that is speculative. It is the least metaphysical of the great generalisations of science. It represents simply our experience of the direction in which physical changes are proceeding. Based upon the most exact methods of science known to us, nothing seems more certain and more capable of rigorous mathematical investigation."

Science, then, teaches us that the clock is inevitably, if slowly running down and that in time it must come to a stop, like any other clock, if unwound. Surely we could hardly want better proof that there must have been a time when there was no clock, or no clock wound up and going.[1] If that were not so, we should be presented with the impossible paradox of a universe which had no beginning but is bound to have an end. And yet, in face of his statements as to the certainty of the data on which the conclusion at which he has arrived is based, and the infallibility of that conclusion—and indeed he has not spoken in any way too strongly about it—the author from whom I have been quoting proceeds: "And yet we are certain that it is not universally true. For there must always *have been* an universe—at least our

[1] "If we accept the theory that the heat of the stars is kept up by their slow contraction, we must think of the universe of stars as of a clock which is running down. As we can see by the eye of reason that the weight of the clock was higher yesterday than it is to-day, so we can compute that the stars must have been larger in former times, and that there must have been some finite and computable period when they were all nebulæ. Not even a nebula can give light without a progressive change of some sort. Hence within a certain finite period the nebulæ themselves must have begun to shine. How did they begin? This is the unsolvable question." Simon Newcomb, "The Stars: a Study of the Universe," p. 219.

intellect is incapable of conceiving beginning. If we suppose a beginning, an unconditioned creation, at once we leap from science into the rankest of metaphysics." What all this means is that if we hold that the universe is eternal and that degradation of energy is still going on, the time when all energy had been degraded and things had come to a standstill must long have been past. But we still find energy available. Therefore there must be some means—though science cannot point to it—whereby the degraded energy can be once more restored. Now the weak point of this syllogism is that the major premise is in dispute. The writer in question says that we cannot imagine a time when there was no universe. Well, this is precisely what all Catholic, indeed one may say all Christian, philosophy does quite calmly and quite easily envisage. It thus offers a reply to the difficulty under consideration which, though some may call it "rank metaphysics," at least to men like Lord Kelvin, and to others is a satisfactory solution of the question.

Let us now state the Catholic solution, which is at any rate simple and definite and is summed up in the statement that "In the beginning God created the heavens and the earth." According to the Catholic belief God alone has existed from all eternity and it was at His fiat that the universe came into existence. There was a time when there was no universe; when there was nothing but God. This solution of the difficulty presented a still further difficulty of a purely philosophical character to Herbert Spencer and others, who were driven to the belief that there must be something more at the back of things than mere blind powers. This great and over-mastering difficulty was that if God—or the Great Unknowable or any other periphrase which may be used by philosophers desirous of avoiding the stigma of old-fashionedness,—if God existed alone and self-sufficient, then we seem to be obliged to contemplate the existence of a subject unprovided with any object, which would be an almost impossible state of affairs. This book is in no sense a manual of theology, nor is it any part of its scope to deal with such mysteries as that of the Blessed Trinity as held by Christians. But this at least may be said, that this

doctrine, as we understand it, does away with the difficulty just raised, since it shows us in the doctrine of the Trinity in Unity that the highest form of existence in the universe is a social form "in which thought is for ever communicated with unbroken harmony of feeling and will."[1]

Another argument which is urged against the Christian idea is that the postulation of a Divine Creator depends upon man's craving for a knowledge of causality. Since everything must have a cause there must be a First Cause. This seems a fair argument, but is countered by the question "What was the cause of the First Cause?" Here we are back again at our old dichotomy: Creator (First Cause) or Self-Existing Matter, eternal and alive.

It is clear that if we adopt the first solution we must at the same time see that we are dealing with a Cause wholly unlike any other of the secondary and tertiary causes which must all be traceable back to it. Catholic Philosophy teaches that when we speak of a First Cause we speak of a Cause which is different from every other cause in that it is a Free Cause, moved only by Itself and unmoved by anything else. Thus it differs from all the unfree causes which we know in nature, which are themselves effects of other natural causes, and these again of others and so on. It is only in connection with a Free Cause that we reach finality.

This is, of course, the barest possible statement of an argument whose full development must be sought in manuals of Natural Theology. It is outlined here in order that readers may be aware that the difficulty has been met and considered and that there is an answer which will seem satisfactory to all but two classes of mind. The first class is that which refuses to believe that any truth can be reached in connection with these ultimate matters and declines to consider anything which can be said about them, in other words, the pure Agnostic.

The other class of mind is that of the man whose first principle it is that there is nothing higher than Matter. Well, if that is an established major premise, as it certainly is in some minds, then clearly there is no such

[1] Robinson, "God and the World," London, S.P.C.K., 1913, p. 49.

thing as a God or a First Cause and Matter is Eternal and it is Alive. We have seen that this theory gets us into trouble with the physicists, and when we come to consider the question of man's higher part we shall see that it gets us into great difficulties there also. But there is no doubt that there are minds which refuse utterly to believe in anything which they would call "mystical," which believe themselves degraded by any such idea and look upon those persons, including Lord Kelvin, Stokes, Pasteur, and other like men of science, who do hold this idea, as "senile" or otherwise deluded. To such persons arguments of the kind now offered will be quite useless. "Everything shows that energy is being degraded." "I know, but since the Universe must have existed from all eternity it cannot be true that energy is really being degraded or there must be some method of reversal." "How do you know that the Universe is eternal?" "Because I cannot imagine a time when it did not exist." "But I can imagine and I believe in a period[1] when there was nothing but the Triune God." "Oh, but you are a mystic!" And then there is no more to be said. Well, the "mystic" ideas are set down here and it may once more be added that they have approved themselves to some at least who were not merely "mystics," but were also recognized leaders of science.

Note to Chapter XII.—My friend Mr. A. J. Rahilly, whose kindness I have already acknowledged, has been good enough to favour me with the following note which may be read in connection with the facts alluded to in the chapters immediately preceding. It deals with the inability of Science to account for the present configuration of the Universe.

Father Secchi's spectroscopic classification of the stars shows us vividly the various stages through which a sun (our own included) must pass in its appointed course. At one end we have

[1] "Period."—It is difficult to find a word comprehensible to the ordinary reader yet one which will not cause the philosophical critic to tear his hair. "Period," of course, generally means a certain section of time—the Victorian Period, i.e. the time during which Queen Victoria reigned over Great Britain. In the sense in which it is used above it means nothing of the kind. For the scholastics *time* implies change. Before the Creation, therefore, there was no time but eternity, that is duration of an unchanging Existence—the "everlasting now." It will be understood, then, that in using the word "period" here it is in no relation to what we think of as "time."

those vast stretches of nebulosity (to be seen, for example, in the constellations of Orion and Andromeda) that seem to be slowly settling into stellar nuclei. Next we have youthful stars (such as Sirius and Vega) which are white or slightly bluish, surrounded by atmospheres principally composed of helium and hydrogen. Stars in their prime (like our own sun or Arcturus) are somewhat yellowish and are swathed in glowing robes of metallic vapour. Stars in their decline (e.g. Alpha Herculis) are of a reddish hue and have banded spectra. Lastly, we have faint dark-red stars, whose spectra are crossed by wide absorption bands probably due to carbon. The final stage of a sun seems to be represented by those dead dark companions of some double stars. We can thus form a very clear idea of the "natural history" of a star. The heavens present us with stars in every stage of their life-history from embryonic nebulosity to dark decline. In this way we arrive at a tolerably vivid conception of the meaning of stellar evolution. The life-period of a star, vast and limitless as it appears to beings whose span is but threescore years and ten, is seen to be merely a momentary scintillation across the dark night of eternity. The suns scattered through space are as fires which light up for a moment and then sink into the gloom. Even the mightiest star delays but little behind its lesser fellows; all alike are hastening to extinction. Some of the stars which we see are just lit; some are expiring. But such differences of age—what are they compared to the ocean of a limitless past? It is as if we compared the different ages of men now on earth with the past epochs revealed by geology. Undoubtedly the stars are *contemporaries*, their lives overlap; they are a conflagration lit up almost simultaneously in the heavens.

This conclusion is one of far-reaching significance. We know that each star is but a fire of brief duration; we know too that all these millions of glittering stars are now lit up simultaneously throughout the vast regions of space; we know that a time will come when all these fitful gleams will be quenched. Did the lives of only two stars overlap, were there only two stars shining in the sky, we might conceivably attribute the coincidence to chance; though indeed, when we think of chance-tossed atoms scattered haphazard through infinite space for all eternity, the probability that two stars would be shining simultaneously is well-nigh infinitesimal. But it is utterly beyond our powers of credulity to believe that myriads of comparatively transient stars should by mere chance light up together throughout space. The more one thinks of this astounding simultaneity of our universe, the more does one become convinced that its gradual evolution from chance-strewn nebulosity is an impossibility. Chance encounters of particles scattered through infinite space could never produce such a contemporaneous illumination. And, even if we draw upon the resources of eternity, we are merely

raising the further difficulty: If the present configuration of the universe is merely one stage in an infinite evolution, why is not the present stage long past and gone? But the present stage is really unique, such a universal conflagration can never again recur, it began once and it will end. The stars are the chronometers of the Creator. By their simultaneous radiance they are always reminding us of the day when God's creative energy started them on their course, "when all the morning-stars sang together and all the sons of God shouted for joy."

CHAPTER XIII

LAWS OF NATURE: PRAYER

IN the processes of Nature, as we observe them, certain orderly series of occurrences take place: certain results follow upon certain causes, and these things we commonly speak of as occurring according to what we call "Laws of Nature." It may be well to devote a little consideration to this matter, since it is one respecting which there is certainly an ambiguity in speech and writing and not infrequently also an ambiguity in people's minds. We speak of a Law in one sense when we allude to the act of a competent legislature. That is a Law which, whether just or unjust, must be obeyed, unless its infringer is prepared to submit to such painful consequences as may follow upon breaking it. Then again there are the Moral Precepts which are not purely penal prescriptions nor man-made ordinances. There are certain things which we need not do but which we "ought" to do. There are also the Laws of Revelation, such as the Ten Commandments, many of which are prescribed by the "natural law" quite independently of any promulgation through Moses.

But when we speak of such a "Law" as the Law of Gravitation or the Law of the Conservation of Energy, we are dealing with a very different matter. Here we are speaking of an arrangement which we have discovered, though our discovery may be imperfect enough and may only partially take count of the factors of the case.[1]

The arrangement in question seems at any rate to be an invariable one as, for example, we have seen that the

[1] No penalty would be exacted nor would anyone be ethically shocked if a stone, thrown up into the air, did not return to the earth in the orthodox fashion. Those who witnessed the occurrence would be merely surprised.

transmission of light through the luminiferous ether is. Then we may speak of the Law of the Transmission of Light. At any rate it will now be clear what is meant by a "Law of Nature" and in what way it differs from an ordinary law dealing with tariffs or what not, which may be here to-day and gone to-morrow. There is at least one point which the two kinds of laws would seem to possess in common. No one can conceive the first form of Law alluded to above coming into existence fortuitously or enacting itself. The Ten Commandments were given to Moses by God Himself, and all the laws of civilised countries have been made by monarchs or parliaments or senates, or such-like bodies. Even the rigid laws of many uncivilised races have been made at some time and by some person or persons and are kept in being by the consent, whether the result of fear or love is of no consequence, of those who live under them.

In other words, it is impossible for us to conceive of laws of this kind which had no law-giver. The idea is grotesque. Yet it is quite certainly true that there are people who firmly believe in what all agree to call "Laws of Nature," who are yet able to persuade themselves that these laws have come into existence by mere chance—that is to say, that they have had no law-giver.

In the preceding chapter we saw that, apart from the Agnostic attitude, there were only two possible views of the Universe in the last analysis :—namely, that it was created by an eternal God, or that it was itself eternal and alive; and we discussed some of the difficulties which attended the latter conclusion. We may now return to the same consideration in face of the fact that, as is admitted by all, there are certain series of orderly occurrences which we agree to name "Laws of Nature," and that the common experience of mankind is that where there is a law there must also have been a law-giver. Let us first of all look at what is involved in the theory that though there are laws there is no law-giver.[1] "The world, so science assures us, at a

[1] The following passage is, with slight modifications, taken from an essay published in my volume, "A Century of Scientific Thought," p. 28. Burns and Oates, London, 1915.

certain date in the past, was a mass of nebulous matter at a terrifically high temperature. Slowly and with vast convulsions and cataclysms, it cooled down. Then by some chance mixing together of some nitrogen, hydrogen, oxygen, carbon, and other elements, in some manner undiscoverable by and even unimaginable by modern chemists, the lowest form of living organism emerged—the offspring of the blindest chance, yet endowed somehow or another with the marvellous power of propagating its kind, and more, with the tendency to vary fortuitously in all directions. Then the Law of Natural Selection, not to speak of a host of other so-called laws of Nature, all of them *ex hypothesi* the result of blind chance, sprang into existence and by marvellously complex co-operations effected the most ingenious and elaborate products without any Law-giver to lay them down or direct their actions. By the simple process of extinguishing the disadvantageous variations, Natural Selection developed out of the come-by-chance Protozoan, all the forms of animal and vegetable life which have flourished on this earth or which now astonish us by their multitude and variety. Finally it brought forth Man—the head and crown of things. And more, far more, the Brain of Man. And what does that mean? Hamlet, Paradise Lost, the Differential Calculus, the music of Handel, the paintings of Botticelli, internal combustion engines, wireless telegraphy, all the poetry of a Wordsworth, all the wonderful inventions of a Kelvin—all these things and a thousand more as wonderful—the Law of Natural Selection, without a spark of intelligence behind it—this perfectly aimless action of physical forces has accomplished all these things. This is the demand which is made upon our powers of belief by those who deny the existence of an Intelligent Author of the Universe and attempt to put forward an explanation of the existence of things as they are. Natural Selection, Conservation of Forces, Propagation of Light, all these so-called laws and all the other so-called laws must be one of two things. They must be the products of mechanical forces acting at random, or they must be the ordinances of an Intelligent Law-Giver. There is no middle term since, as we have seen,

there is in the last abstraction nothing between believing in a Being—a Law-Giver—who is something in Himself, apart from the universe, and believing in a mere abstraction from or generalisation of natural laws or processes, and that, as apart from a Law-Giver, means nothing more than Blind Chance."

Or, again, we may regard the question from a slightly different angle. It is quite clear that an infinite number of different universes are logically conceivable. Yet only one is actually realised. Why? The question has at least a meaning—in spite of the assertion of monists. We could quite easily conceive gravitation to act according to the inverse-cube of the distance, or we could imagine light travelling twice as fast as it does. The fact that things are what they are, when logically they might be otherwise, is the fundamental fact which we have to face. The real concrete world is all around us and is clamant for an explanation. The attempt of philosophers to explain it logically is a hopeless failure. No amount of *a priori* thought will determine the colour of gold or the boiling-point of water. The various orderly modes in which the actual world is found to act are, as we have already seen, termed "laws of nature." These are the "orderly modes" which actually exist but they are not inevitable *a priori*, in fact one can conceive a universe in which they were all replaced by different modes. Reason imperatively demands some real principle of selection (i.e. creation), some actual pre-existent factor which out of the infinity of possible worlds selected and actualised the world as we know it. The popular materialistic view accepts a nebulous congeries of chemical elements as a primary datum and tries to see the world of life and intelligence latent therein. To accept, without explanation, the existence of hydrogen atoms—each a complicated world in itself—all perfectly similar and vibrating in perfect unison across the measureless distances of interstellar space—surely this is an enormous demand on our faith. Having once posited an inorganic world of marvellous mechanisms and complex affinities, it is quite easy to smuggle in a few protozoa. Having swallowed a camel, it is not worth while straining out a gnat!

Faced by the actual world of chemistry and biology, we must choose one of two courses. Either the Laws of Nature are ultimate inscrutable data impervious to logic and amenable to no explanation, or else they are the laws of a Law-giver, the orderly modes in which the creative Mind of God expresses Itself.

The matter which we are now considering is so well illustrated by a portion of the discussion between Fr. Wasmann and certain materialistic champions which excited so much interest some years ago in Berlin, that I shall give some account of that part of the proceedings which concerns us at the moment.[1] In his speech Professor Plate, a leading exponent of materialistic views, lays down his position, and it is that of many others, very candidly and very clearly. He says:[2] "The monist *asserts nothing* about the nature of God, but limits himself to the laws of nature. These laws are, indeed, the only things that we can establish with certainty; with regard to what underlies them there are many different opinions, and we monists are not all agreed on the subject. *Personally, I always maintain that, if there are laws of nature, it is only logical to admit that there is a law-giver.* But of this law-giver we can give no account, and any attempt to give one would lead us into unfounded speculations. It is there that faith begins," he continues, "and many of us have given up all faith."

One initial criticism must be made on this important remark—the monist here described is not what we should understand by that term. A monist to English-speaking persons is one who believes in some shape or form in matter alive and sentient, whether under Haeckel's so-called Law of Substance or otherwise. Such a person scoffs at, or at least utterly denies, the idea of a God, in any proper sense of the term. The kind of person for whom Professor Plate is speaking is one who would with us be styled an Agnostic, to use the now commonly received term originally invented by Huxley. But the really important point is that this champion of monism, as he calls himself, freely admits that

[1] A full account of the discussion, with comments by Fr. Wasmann, will be found in his "Problem of Evolution," London, Kegan Paul, 1909.
[2] P. 108. Italics here and elsewhere as in original.

if there is a Law there must be a Law-Giver. This would seem a logical necessity were it not clear that it does not appear to be so to all persons. Fr. Wasmann remarks on the statement : " Plate's own confession *that where there are natural laws, there must be a law-giver,* is one of the utmost importance. A law-giver *underlying* the laws which He has made, cannot be identified with those laws, for otherwise He would be superfluous, as the laws of nature would suffice *independently* of Him. Therefore the originator of the laws of nature must be *an exalted and intelligent being,* in fact, *the personal Creator* recognised by theism."

We saw the difficulty that there was to account for Matter, and that in motion, and the alternatives offered for our choice. The same alternatives are before us in considering the maintenance of the Universe, for that is the question now before us, the Laws of Nature being merely our description of the plan by which the Universe is maintained. Of course, there is the objection, not very profound it will be granted, yet often made : " You say that God created Matter and set it in motion : How did God come to be or who created Him ? " Here it is not possible to undertake the full discussion of this question, but this may briefly be said :—

Matter is limited in all sorts of ways. It has not in itself any reason for its motion, much less has it any reason for its existence. It is difficult to imagine a thing so limited being the sum of things. The theist postulates an infinitely perfect Being containing in Himself the reason of His existence and therefore eternal, and maintains that only an infinitely perfect being, could contain in Himself the reason of His existence. Having postulated such a Being, he proceeds to show that his explanation coincides with the facts and explains them. As the Church teaches, it is possible to arrive at a knowledge of God from natural argument, therefore the theist reaches it. Having reached it he may consider and attain to a belief in Revelation—a matter with which we have nothing to do at the moment—which will enlarge his ideas of the Deity and throw light upon His providences.

This preliminary discussion on the manner in which the

Universe is maintained will lighten very greatly the task which has to be essayed in the remainder of this chapter and the next, namely, the discussion of the relation of Prayer and of Miracles to the Laws of Nature with which we have been dealing. Let us first deal with the question of Prayer. And to begin with, let us dispose of the shallow argument that this question may be approached, as mere scientific questions are, by means of experiment. Experimentally no doubt Christians are aware of many graces, temporal as well as spiritual, which have been obtained as the result of prayer; but to argue, as some have tried to do, that we may make an experiment in this matter, with the ordinary controls, is to suppose that material and spiritual things are of a like character, a common but most fundamental mistake. Even in this world it would be an injudicious, not to say dangerous, thing to let the person from whom we are seeking an exceptional favour suppose that we were making him the subject of an experiment. It would not be tactful, neither would it be respectful, and it would be most unlikely to be attended by any favourable result to our request.

Those who are opposed to our ideas on this matter must allow us to lay down certain fundamental propositions which, of course, we must eventually prove, but on which we found our argument.

In the first place we postulate a personal God and we believe Him to be omnipotent and the Creator and Maintainer of the Universe. From this it follows that He is Himself the formulator of what we call the Laws of Nature, in other words, He is the Law-Giver of whom we have been speaking. He does not "break" His laws because what people sometimes maintain are breaches are matters which were provided for when the laws were first conceived. If there be a God, nothing is more sure than that He has told those who believe in Him to approach Him in their need by prayer, and, according to our view, the fact that such prayer may, if the gift be to our eternal benefit, be granted, is as much a Law of Nature, that is a Law of God, as any of the other laws we have been speaking of. But it is a law in the spiritual world first of all and not, like the other laws,

first of all in the physical world. And that being the case, it relates first of all to our spiritual nature as to which the law is unvarying. It is in its secondary or natural aspect that it seems to vary. Let us look at this a little more closely. No one who studies revelation even in a cursory manner can doubt that it teaches us that if we approach our Maker in the way which He has laid down for us, we shall receive an answer to our prayers, for it is by prayer that we have been instructed to approach Him. Further, it is a very remarkable thing that, apart from Revelation, the instinct of prayer is found to exist in all races and in all ages. It seems to be—can there be any doubt that it is ?—a fundamental part of human nature as much as any of the natural needs of food and sleep. It may be said that there are many highly cultured persons who get on without it. That this is so would certainly appear to be the case, but it may at least be argued that as the body can be made to do with very little food and dies if it is entirely deprived of it, so the invisible soul, which is deprived of its proper nutriment, may be in a very parlous condition and one which would excite our sincerest sympathy were it visible. This, however, is a subject for a treatise on Moral Theology and is out of place here. There are two points briefly to be considered.

Can prayer alter the ordinary course of nature ? Is it any good praying for fine weather, for example ? What is the nature of God's special dealings with natural phenomena which we commonly ask for in prayer ? God's ordinary co-operation is not enough, for this is essential quite apart from prayer. Of His extraordinary or special providence there would seem to be three possible explanations, which can, of course, all operate together.

(i.) There is the significant *fact* that human wills can alter and direct the operations of nature. No amount of metaphysical quibbling or scientific theorising can alter our intense conviction that we have an initiative of our own, a power of controlling our actions.

So long as this fact of human freedom remains to baffle psychologist and physiologist alike, it is absurd to seek an impossible clarity concerning God's direction of nature.

Does it not seem clear that our scientific analysis of nature is incomplete and imperfect ? And is not this proved by the simple fact that science is utterly at a loss to account or allow for Free Will and its operations ? This is the fundamental contention of Bergson's philosophy and, however disputable the details of his theory may be, the widespread popularity of his system is a sign that men are growing tired of the narrow pretentious claims of a scientific scheme which is baffled by the really vital factors of existence. This being so, can we wonder that God's Will also eludes our scientific scheme ? We must have patience. Science is as yet in the go-cart. It cannot explain the free action of men, much less those mysterious psychic phenomena which (in spite of the opposition of science) have of recent years come more and more into prominence. One thing is certain : human minds provide centres of action, open windows for God's light and influence. Just as our souls can act on matter and yet somehow not break "natural laws," so surely God can act on our souls and thus indirectly influence the course of earthly events. Thus when we pray for the conversion of a friend, it does not follow that our request in any way involves an abrogation of the laws known to science.

(ii.) It is a prejudice of mechanistic science to regard the universe *en bloc* as a rigidly connected system. Were we to interpret physics with minute literalness we should be compelled to admit that a man taking off his hat in London physically disturbs me writing here in Cork. Yet that is literally what determinism amounts to : everything is determined by everything else. Further, the taking off of his hat by the man in London was predetermined by the peculiarities of the nebula of which this earth was originally composed ; nor could he have acted otherwise than take it off and thus incidentally and unknowingly produce a physical disturbance in Cork and elsewhere, however desirous he might have been of leaving his headgear undisturbed. Physics, like other domains of science, must be accepted as a first clumsy approximation to reality. The ordinary mathematical treatment of light, for instance, always presupposes that the light-source has been shining

for all eternity! The ordinary student, conscious that the light has just been started in the laboratory, does not perceive this assumption. But it is there nevertheless, and similar artificial simplifications occur everywhere in science for him who looks below the surface. The assumption that the effect of every *new* event—whether it be the shuffling of our feet or the switching on of the electric light—is propagated everywhere in space and upsets the universe, is merely a naïve interpretation which is unavoidable in the present state of scientific methodology. In reality events happen in causal chains. One set of events takes place without the slightest influence on another set. In fact, when two such disconnected streams of events cross, we regard the occurrence as a fortuitous coincidence. When a man is accidentally run over by a motor-car there is no causal nexus between the histories of the motor-car and the human being. The motor and the man, each moving on its own course of action, happened to arrive at the same point of space at the same instant of time. That is all.

If we now regard the physical world as a network of more or less discontinuous causal threads, it is obvious that the crossing or intertwining of such threads is not predetermined by the threads themselves. The resultant pattern which they weave is either due to what we call chance or else is intelligently directed. Chance, however, is not an ultimate explanation; and inevitably our analysis travels back to the initial conditions, i.e. unless Free Will intervenes. In the case of intelligent beings, we can only say that choice is the determinant. It was the man's free decision to cross the road which brought him within the physical range of the motor-car.

This discussion, however cursory, is sufficient to make us realise that the world is by no means so rigidly predetermined as many enthusiastic votaries of science would have us believe. There is room for free play; chance has a real objective significance, viz. the intercrossing of independent causal chains, and is not a mere cloak for ignorance. Not alone is a large part of natural occurrences within our own control, but there is opportunity for God's special direction of events without any contravention of

the laws of science. We cannot see far ahead; for aught we know, a small change of present plans may result in far-reaching future consequences. And many present realities were once frail possibilities hanging on slender causal threads; did not England's present mineral wealth and insular position originate in some chance-formed heterogeneity in a nebula? All these life-histories of countries and individuals stand spread out to God's eternal gaze. At each stage He sees the possibilities foreclosed or initiated; He influences development by the primal distribution in the past and by direction and inspiration in the present.

(iii.) Laws are but the ordinary modes of God's action laboriously inferred by us from slow and patient observation of nature. To erect these laws into final boundaries of thought is to deify our own puny discoveries. The question as to whether breaches of these laws occur is entirely one of patient investigation. That miracles do occur will be shown later on. At present miracles are presented simply as a third possible mode of God's answer to prayer.

It is only fair to admit that, with the advance of science, men have become more chary in asking for miracles. When meteorites, comets, animal monstrosities and such-like were regarded as prodigies, when physical and chemical phenomena were as yet vague and uncertain, it was but natural for men to enlarge unduly the sphere of God's miraculous intervention. It is worth noting, however, that men were never so foolish and credulous as to pray for the miracle of "a centaur."[1] They merely asked for God's miraculous succour in circumstances where we should now rely more on God's ordinary providence. It may be true that nowadays the outbreak of pestilence sends men to the drains; but even apart from the question of miracles, it would be well if it also sent them to the churches.[2]

[1] See p. 147.

[2] For a very interesting and suggestive discussion of the subject of prayer the reader may be referred to the Rev. Ronald Knox's little book "Bread or Stone," published by the Society of SS. Peter and Paul, London, 1915.

CHAPTER XIV

MIRACLES

WE have now to pass to the consideration of the subject of Miracles, and with certain points in respect to those occurrences we must now proceed to deal, referring readers desirous of following the question further to the various Catholic treatises on the subject.[1]

First of all, what is a Miracle? St. Thomas Aquinas says that "miracles are effects wrought by the power of God alone in things which have a natural tendency to a contrary effect, or to a contrary way of producing it." And again, "Those effects are rightly to be termed miracles which are wrought by divine power apart from the order usually observed in nature."

It takes place by the power of God: no doubt, but so do all positive effects come about. That is true, but in the case of the miracle the effect is one "which, considered in the concrete with all its circumstances, is manifestly proportioned to the Divine Power alone. . . . By the words 'in things which have a natural tendency to a contrary effect, or to a contrary way of producing it,' St. Thomas implies that the effect of a miracle is either something which in the ordinary course of nature never happens, or something which in the ordinary course of nature does not happen in this way. Of the first kind is the raising of a dead man to life again, of the second kind the cure of a very serious disease by a simple command,"[2] or, it may be added,

[1] Those who desire to find the matter briefly but fully discussed may be referred to the article "Miracles" in the Catholic Encyclopædia, to which the present writer acknowledges his indebtedness. The reader may also be referred to Fr. Joyce's excellent little book "The Question of Miracles," Manresa Press, London, 1914.

[2] Boedder, "Natural Theology," p. 414, 5.

suddenly instead of slowly as would be the normal method of cure. Or again, it is defined by theologians as *Opus sensible, divinitus factum, insolitum, supernaturale ;* a sensible, unusual, divine, and supernatural work.

It is sensible : appreciable by the senses, therefore does not extend to matters like the creation of the human soul or the Blessed Sacrament.

It is unusual : because it is opposed to the ordinary course of nature.

It is divine : because it is the special work of God. We hear and speak of the miracles of the Saints, but that is a loose way of putting the matter. What is really meant is a miracle worked by God at the intercession of or by the instrumentality or ministrations of a Saint.

It is supernatural as well as divine : because it is not one of those works of God, such as the creation of an individual soul which completes the natural existence of corporeal things in the case of man.

At this point it may be well to take notice of the very loose way in which the term "miracle" is used, not only in common speech but even in what are supposed to be grave discussions on this question. We are all accustomed to hearing such and such an object spoken of as a "miracle of beauty," or a "miracle of ingenuity," and we understand such phrases in the sense in which they are meant, namely, as very outstanding examples of beauty or ingenuity. No real confusion arises here, but it may do so in the case of what would be more properly called a "special grace," though often loosely spoken of as a "miracle." A very remarkable and a very sudden cure of a disease may not be in any kind of way a miracle in the strict sense of that word, yet it may be a very special grace and one given in direct answer to prayer.

There is a further matter which may perhaps be noted at this point and that is the curious frame of mind of many outside the Church, yet sincere Christians according to their lights, who, whilst accepting the miracles recounted in the Bible, completely refuse to believe in any of a later date than those of which we read in the Acts of the Apostles.

This frame of mind is perhaps rarer than it was a few years ago. So also—and with thankfulness we may admit it—is the often associated frame of mind which did not hesitate to assert that Catholic ecclesiastics had invented these stories, and disseminated them to delude the unfortunate dupes who formed their flocks. This dreadful accusation, once common in the mouths of really respectable persons, is now confined, so far as public utterance at any rate is concerned, to individuals whose opinion on any subject is worthy of but little attention.[1] Yet there are others outside our body who in increasing numbers do not hesitate to give in their adhesion to the truth of miracles which were laughed to scorn but a few years ago, such as the stigmata of St. Francis. Here again we must distinguish from those whose view about the matter in question in no way differs from our own, those who, convinced by evidence which it is admitted cannot be gainsaid, that St. Francis really had the stigmata, explain the fact by "suggestion" or "hysteria," or some solution making out the occurrence to be purely natural in its character. For example, a recent writer[2] does not hesitate to say, "We believe that it was Jesus Christ who gave St. Francis the stigmata, because we are Christians. If we were not Christians, we might equally well attribute it to Allah, or to Zeus, or to any conceivable agency—beneficent, malevolent, or merely neutral—which may exist in the unknown world that lies behind and beyond material phenomena."

[1] A good example of the change of opinion in this direction may be found in the treatment of the question in the book entitled "Medicine and the Church [of England]—Being a Series of Studies on the Relationship between the Practice of Medicine and the Church's Ministry to the Sick," London, Kegan Paul, 1910. In this *inter alia* are quoted the remarkable utterances of the late Henry Butlin, an ex-President of the Royal College of Surgeons, in which he rebukes those who would impute wilful deceit to the clergy and others associated with the manifestations which take place at Lourdes. See also "British Medical Journal" for June 18, 1910, and "The Corner of Harley Street." Unquestionably the general attitude of Christians outside the Catholic Church towards post-Apostolic miracles is one of complete incredulity. This is the attitude, for example, of Colonel Turton in his very interesting and valuable book "The Truth of Christianity," of which mention has already been made. See also "Medicine and the Church," p. 202. To what this leads will appear in the course of this chapter.

[2] The Rev. R. A. Knox, Fellow and Chaplain of Trinity College, Oxford, in "Some Loose Stones," Longmans, 1914, p. 183.

These very striking changes of opinion are in large part due to the remarkable occurrences associated with Lourdes and elsewhere during late years, and the careful study which has been devoted to them and, it may be added, to various nervous conditions which cannot be left out of count when we are investigating the truth of a given miracle. From all this study certain very definite facts appear to emerge which will be dealt with as occasion arises in this chapter. The first of these is that a number of very remarkable things do occur at Lourdes and that they are honest occurrences—not, as would have been asserted at one time, "faked" by artful and designing clerics. Further that similar things happen at other places under religious influences and that all these things must be accounted for in some way or another, since their occurrence can no longer be disputed nor can they be summed up as frauds. How are they to be accounted for? The Catholic attitude is that they, or some of them, are, or may be, those direct operations of Divine Omnipotence which may properly be called miracles. "May be"; it is necessary to repeat and to accentuate these words; for nothing is more remarkable than the ignorance of persons outside the Catholic Church as to the attitude of that Church with regard to this very matter of miracles.

The common idea is that the Church is ready to claim any triviality, one might even say any absurdity, as a miracle, whereas the real truth is that when it comes to making a pronouncement on such a matter—and how rarely is any pronouncement made!—the evidence required must be overwhelming and conclusive. Further, it is commonly believed that priests and bishops welcome the news of supposed apparitions, such as that of Our Lady at Lourdes, because of the vast sums of money which they expect will follow to the favoured spot; whereas nothing is clearer than the fact that Bernadette and other seers have had to submit to the most severe examination, not to say snubbing, on the part of their ecclesiastical superiors before even a mitigated credence was given to the occurrences which they professed to have witnessed. The direct opposite to our position is the strange and unphilosophical view that miracles

do not occur.[1] Such, it seems, was the attitude of Zola, who visited Lourdes, made a study of what occurred there, and then wrote what cannot be considered other than a very dishonest book upon the subject. In the book in question there is, for example, a character named La Grivotte, who, it is generally admitted, was intended for a real person still alive, or alive until recently, named Marie Lebranchu. Marie Lebranchu was diagnosed as suffering from an advanced condition of pulmonary tuberculosis and, as far as the present writer is aware, the diagnosis has never been disputed. She was cured at Lourdes, subsequently married, became a widow and lived for many years—may even be alive to-day—without any relapse, a sufficiently remarkable cure to put it at its lowest. Now mark what Zola makes of it. La Grivotte is permitted to be miraculously cured at Lourdes, but on her return home relapses and not long afterwards dies of the same disease.[2] There is no doubt that Zola took the trouble, when writing the book, to hunt up the prototype of La Grivotte, and that he found her alive and well, as she remained for many years after the novelist's dreadful end. When taxed by Dr. Boissarie—the chief physician at Lourdes, who had been Zola's host at that place and had given him every opportunity for making a complete examination into the events taking place there, with his treatment of this case—the novelist cried out in tones of annoyance, " I suppose I am master of the persons in my own books, and can let them live or die as I choose." And then he added these words, " And besides, I don't believe in miracles : even if all the sick in Lourdes were cured in one moment I would not believe in them ! "

Midway between these two views is the view which would perhaps be described by its holders as the " commonsense attitude " of Hume and Huxley, men too philosophically minded to adopt the attitude of Zola, yet far too materialistic to credit anything of a supernatural character.

[1] Some of the pages which follow have been taken, in large part verbatim, from an article on this subject by the present writer which appeared in the Jubilee Number of the " Catholic World," April, 1915.

[2] See " Lourdes," by J. Jörgensen, Longmans, Green & Co., 1914, p. 179. Also R. H. Benson, " Lourdes," London, Herder, 1914.

This view may be roughly summed up as stating that of course, if there be a God, there may be miracles, but that the amount of evidence which would be required to establish a miracle is so great that it is never likely to be reached and certainly has never yet been reached. This attitude really amounts to this: " I am so certain that there are no such things as miracles, that I cannot conceive of such evidence being brought before me as would convince me that I am wrong in this conviction." Huxley in his work on Hume,[1] for example, discusses what amount of evidence would induce him to believe that a live centaur had recently been seen. If Johannes Müller, whom he describes as " the greatest anatomist and physiologist among my contemporaries,"[2] were to assert that he had seen a centaur, Huxley admits he would have felt staggered and would have suspended judgement. Nothing less, however, than a careful monograph from a noted anatomist, with full description and plates, would suffice to make him believe in a centaur. *Mutato nomine*, the Catholic would and will thoroughly agree with Huxley, however much it might have surprised that eminent man to hear it, with regard to miracles. No Catholic would for a moment deny that the most rigid and irrefragable proof should be, as it is, required by the Church before any event is finally and definitely declared to be miraculous. Hume's attitude to the question is exhibited by the following well-known passage: " There is not to be found in all history any miracle attested by a sufficient number of men, of such unquestioned goodness, education, and learning as to secure us against all delusion in themselves; of such undoubted integrity as to place them beyond all suspicion of any design to deceive others; of such credit and reputation in the eyes of mankind as to have a great deal to lose in case of their being detected in any falsehood; and at the same time attesting facts, performed in the public manner, and in so celebrated a part of the world, as to render the detection unavoidable: all which circumstances are requisite to give us a full assurance of the testimony of men."

[1] Great Writers Series, New York, The Macmillan Co., 1881.

[2] Who, by the way, was a Catholic. See his life published in " Twelve Catholic Men of Science " by the Catholic Truth Society.

We may freely admit that with regard to a number of "miracles" related by the earlier and less responsible hagiologists—miracles on which the Church has never set her seal—there is no real proof forthcoming, nor is any likely to be produced. But much evidence of occurrences claimed to be miraculous has been forthcoming, and has been carefully sifted, since the time of Huxley, not to say that of Hume; and it would be difficult to show that some at least of this evidence does not comply with Hume's requirements. The result of all this has been to cause the sceptic to shift his ground and, instead of denying, as Hume would have done, the occurrence of the events, to state that they occur but are not miraculous. In this, as in other matters, we have to come back to human testimony. The solipsist denies any importance to anything not appreciated by his own sense, and thus commits intellectual suicide. The world at large judges otherwise, and it would be difficult to find more water-tight evidence than is available in connection with certain modern occurrences claimed to be miracles, explain them how we may. It is not too much to say that evidence equally strong, but in another direction, would certainly send the most respected of the Archbishops of Canterbury to the gallows for murder.

If miraculous occurrences take place, they must be explained. Our explanation is well known: some of them are miracles, some of them are, at least, very special graces. The other explanation is that they are the result of "suggestion." Suggestion no doubt may and perhaps does account for many occurrences which, in a less critical age, might have been claimed as miraculous, but which would not be so thought to-day by educated Catholics. Of course it may be said that the still more critical to-morrow may dispose of things which to-day we suppose to be miraculous. To which it may be replied that such an upheaval of all our medical ideas, even the most fundamental, as this would require is absolutely unthinkable, as will appear later. Whilst admitting all that may be said as to the efficacy of "suggestion" in a considerable number of cases, it is at least permissible to ask why only, or almost only, at Lourdes

is the result of self-suggestion available? Mr. Belloc[1] asks: "If what happens at Lourdes is the result of self-suggestion, why cannot men, though exceptionally, yet in similar great numbers, suggest themselves into health in Pimlico or the Isle of Man? It is no answer to say that here and there such marvels are to be found. The point is that men go to Lourdes in every frame of mind, and are in an astonishing number cured." Of course we may be met with the argument that the religious form of suggestion is the strongest known; but the materialist who ventures on that argument is on very dangerous ground for himself, as a very little consideration will show.

But over and above all this, the fact remains that there are certain cases cured, or reported to be cured, at Lourdes and elsewhere, into which it is quite impossible to suppose that the element of suggestion can enter, and of which it may be said that if, *per impossibile*, it were to be proved that it did enter, the whole edifice of medical and surgical science would have to be reconstructed. Such are cases of broken and ununited bones, cancers, large destructions of tissue by lupus, and other such conditions not of a nervous origin, or to any extent capable of being influenced by the nervous system. Every medical man knows the protean character of the manifestations of hysteria, and can make a guess at least as to the vagaries of which its victims are capable. But no medical man will argue that suggestion will instantaneously cure a broken limb even in an hysterical person.

Further, with such a condition, or with cancer, or any other grave organic disease, nature seems to be too sufficiently occupied to couple with it an hysterical condition. Lastly, hysteria, though not wholly unknown, is rare in men, amongst whom a great number of the cures at Lourdes take place. In fact, the cases of the most remarkable character are just those in which the hysterical element is least, if at all in evidence. Take, for example, the case of Gargam,[2] seriously injured, almost unto death, by a railway accident. His spine was dislocated, as the Röntgen rays

[1] In his preface to Jörgensen's "Lourdes."
[2] See Jörgensen's "Lourdes," p. 161.

proved; he was paralysed, and his limbs in places gangrenous. He was declared by many doctors to be incurable, and on that account was awarded a life annuity by the law courts. He had abandoned his religion, but, to please his mother, and apparently without any expectation of a cure, he went to Lourdes, and was instantaneously cured of all his ailments. Or take the case of Marie Lemarchand,[1] who was cured, also instantaneously, of a most severe form of lupus which had converted her countenance into a thing of repulsive monstrosity. Sixteen years after the cure, which is the last account of her, she had suffered from no recurrence of the disease. These are but samples of the more serious cases which have been cured at Lourdes, and the difficulty of explaining them on the "suggestion" hypothesis is intensified by their number.

The last-named case was admittedly the original of Zola's *Elise Roquet*, of whom the novelist asserted that she suffered from "an unknown formation of ulcers of hysterical origin." Now apart from the two important facts that lupus is as well known a form of disease as any that ever comes before a medical man, and that it has nothing whatever to do with hysteria, so far as anyone knows or has ever to my knowledge suggested, the line of argument pursued in this matter by Zola, when placed in the form of a syllogism, would not deceive a babe in logic. His major premise is that there are no ailments cured at Lourdes which are not hysterical in their character. But Marie Lemarchand was cured there of lupus. Therefore the disease of which she was cured was hysterical in its origin, and as lupus is not that, we will call the condition one of ulceration (which it was) and of unknown origin (which, by the way, it was not).

Finally, let us glance at the very remarkable case of Pierre de Rudder, cured not at Lourdes, but at Oostacker in Belgium.[2] His leg had been broken by the fall of a tree, and the fragments of bone remained ununited, in spite of surgical

[1] See Jörgensen's "Lourdes," p. 175.

[2] As this place and the village where de Rudder lived have been in the centre of the hottest fighting for some months, it is to be feared that no trace of the shrine or of either village now exists.

efforts, for eight years. His condition was known to all his neighbours and to medical men in the district around. Yet he was instantaneously cured after praying at the shrine.[1] There can be no kind of doubt that the limb was broken, and the fragments ununited prior to the cure: that rests on evidence which cannot be gainsaid. Nor can there be any doubt that the bones did reunite, for they are to be seen to-day,[2] and bear unmistakable evidence of having been fractured and reunited. For the instantaneous character of the cure there also appears to be abundant evidence. Suppose that the cure had, after eight years of suffering, occurred very slowly and without surgical aid. That would be almost incredible to any medical man. But that it should have been instantaneous takes it out of the category of natural possibilities, unless, as I have said, the whole foundation of our medical knowledge is inaccurate.

Too much stress in this and other cases can hardly be laid upon the *instantaneous* nature of the cures. Nature does sometimes cure patients suffering from tuberculous and other usually incurable diseases, but never long ununited fractures, nor, I think it may be said, true cancers nor various other things of a severe and chronic character. The cure, however, is slow; never, I think it may be fearlessly asserted, instantaneous, as is so often the case at Lourdes and elsewhere.

What we have to ask ourselves in face of any alleged miracle which comes under our notice, is what the authorities of the Church have to ask themselves when called upon to pronounce judicially in such cases: Did things happen as they are said to have happened? Can the thing which happened be explained upon natural lines? Both of these things are matters of evidence, and the proofs which will

[1] Numerous accounts of this remarkable cure have been published. The best known to me is " A Modern Miracle," from the French of Alfred Deschamps, S.J., M.D., SC.D., published by the Catholic Truth Society of Scotland in 1906, in which a very full account, with illustrations of de Rudder and the bones of his legs which were removed after his death, is given. Another account in a book entitled " Heaven's Recent Wonders," is vitiated by the fact that the cut of the sound leg is described in the text as that of the injured and healed member.

[2] If they have escaped the peril of war. At any rate, they were removed and placed in a museum after de Rudder's death.

convince one man will perhaps not suffice for another. No one, however, who is not totally deaf and blind to all evidence, can deny that the evidence in quite a number of cases is uncommonly hard to get over. In fact, it is only to be got over by the subterfuge of assuming that there are no miracles, and that what seem to be such are occurrences under laws of which we are still in ignorance.

But see what comes of this. In a non-critical age it was still possible to sneer at post-Apostolic or "Church" miracles, and to retain an undiluted belief in those narrated in the Bible. But that cannot be done nowadays: so we find the Bible miracles naturally explained, or explained in accordance with Dr. Sanday's statement,[1] that a "miracle is not really a breach of the order of nature; it is only an apparent breach of laws that we know, in obedience to other and higher laws that we do not know." In a sense this statement is quite correct, and its author may be perfectly orthodox in his meaning; but no one doubts that, in the minds of many, such an explanation is equivalent to a statement that miracles act according to or under natural laws. After all, the essential element in the notion of *miracle* is exception to, or derogation from, the laws of nature. Whether this be effected by God's ordinary concurrence or co-operation with secondary causes or by His introduction of some higher agency, His action must be really an interference with the general order of nature. But nothing is gained by ascribing this event to a "law." Indeed it is precisely in this fact of individual intervention that the supernatural revelation of God is manifested, and just in this lies the probative force of the Gospel miracles to which Christ so frequently appealed.[2] Moreover, when it has once been admitted that the free-will of man can intervene and alter the current of physical causation in his own organism and immediate environment, it is not easy to see why any theist should find insuperable difficulties in believing that a Personal God may, in analogous manner, intervene and modify the general order of nature.

Here we may revert to what has already been alluded to,

[1] "Life of Christ," viii, *teste* "Medicine and the Church," p. 202.
[2] E.g., Matt. xi. 5; John v. 36.

viz. the "unknown" law of Spinoza, who held that the term miracle should be understood with reference to the opinions of men, and that it means an event which we cannot explain by means of the experience which we have at hand but which may be explained when further experience has been gained by the race. Thus the things that we are enabled to see by the aid of the Röntgen rays would have been thought to have been miraculously seen until the discovery of the actual *modus operandi* was made. Up to a point all must admit the truth of this observation; yet there remains a residuum of things which, as has been suggested, it seems impossible that anything but the theory of a miracle can account for. Again, it seems perfectly clear that, if God is infinitely powerful and infinitely free, as of course He must be, miracles are possible. But then, it is argued, God cannot contradict Himself, as He would be doing if He permitted the laws which He Himself had set up to be contravened upon any occasion. This argument is forcibly put by Spinoza:[1] "If miracles are, strictly speaking, all above nature, then you must admit a break in the necessary and immutable course of nature; which is absurd. It would follow also that the principles of reason are violable, for after all they are but laws of nature. In that case we are unable to trust them, unable to prove the existence of God; and thus miracles, far from being a help to the knowledge of God, prove a total impediment to that knowledge." Here, however, Spinoza confuses two things, viz. principles of nature and principles of reason.[2] No miracle could alter the equation $2 \times 2 = 4$ because that is a principle of reason, an enunciation of an inviolable truth. But no principle of reason is infringed by the instantaneous cure of a broken leg. It is only the instantaneous part of the thing which is claimed as miraculous[3] and, as we have often to be reminded, the element of time is not one which comes into operation in connection with the Eternal Being.

[1] For the full discussion of this question see Boedder, *op. cit.*, p. 425.

[2] *Cf.* St. Thomas Aquinas, "De Potentia," q. 6, art. i, obj. 11.

[3] The distinction between the two classes is very humorously brought out in Mr. Chesterton's "Innocence of Father Brown," where the thief posing as a priest is detected by just such false theology. As the genuine priest is made to say—" Reason and justice grip the remotest and loneliest

Lastly, we have to see what is the natural corollary of trying to explain away the numerous post-Apostolic miracles which seem to attach themselves so closely to the Catholic Church and which have been so forcibly repudiated by other Christian denominations as well as by unbelievers. If we must and can explain away the "Church" miracles, why may not a similar method be pursued with the Bible miracles—indeed, must we not in common honesty pursue it? But what comes of this? First, that there was no Virgin Birth, though it is difficult to see how any other theory tallies with the age-long belief that Our Lady was the flower of all virginity and of all womanhood, or is compatible with the view, which surely is not too high an estimate, that she was an ordinarily good and modest woman. Second, that the miracles of Our Lord were worked on perfectly natural lines, that He knew this, yet appealed to them as proofs of His mission; and, in spite of this deceit, He is to be looked upon as at least the best of men, and a model for us all. Again, either the Resurrection never took place at all, or a very different interpretation must be put upon it from that taught by the Church through the centuries. Yet the Church in her corporate capacity was there to see it, and the evidence of eyewitnesses in its favour is at least as strong as that brought forward in verification of any other historical event. And so on, and so on.

In all this we trace the corrosive effect of a general revolt from authority. It eats away first one thing, then another, until nothing is left but a few useless and apparently unrelated fragments. This is not a work on inter-credal polemics, so that this matter will not be pursued any further, nor would it have been introduced at all had it not been necessary to show that a distorted view of the question of miracles, such as is held by many outside the Church, logically leads up to a renunciation of those miraculous

star. Look at those stars. Don't they look as if they were single diamonds and sapphires? Well, you can imagine any mad botany or geology you please. Think of forests of adamant with leaves of brilliants. Think the moon is a blue moon, a single elephantine sapphire. But don't fancy that all that frantic astronomy would make the smallest difference to the reason and justice of conduct. On plains of opal, under cliffs cut out of pearl, you would still find a notice-board, 'Thou shalt not steal.'"

events which others than Catholics hold sacred. This does not prove their truth. That can be attempted and with success, as we believe, on different lines. What it does show is that the doubt as to the possibility of occurrence of one kind of miracle and the belief in that of the other is not a very logical position for anyone to occupy.

CHAPTER XV

GEOLOGY

WE learnt in connection with the Nebular Theory that the earth on which we live may very probably have consisted originally of a whirling mass of nebular substance abstracted, so to speak, from a much larger and equally whirling mass from which our solar system has taken its origin. As this nebula revolved, it gradually contracted and became a spherical mass of molten substance from which at some period or another it would appear that the moon may have been thrown off. Still revolving and slowly cooling, the earth gradually consolidated and became what it is to-day. The science which reveals to us the occurrences of the long-drawn ages, since the earth can be said to have deserved that name, is known as geology. Here we begin to come into contact with subjects with which religion is closely associated, and hence it will be necessary briefly to describe the scope of geological considerations and to deal with the points where religious interests are engaged. This will be the task of the present and of succeeding chapters.

In the first place, then, it may be said that there are at least three aspects of geology with which we are fundamentally concerned. First of all, enquiry must be made into the agencies by which the earth has come to be as it is. It is the task of Dynamical Geology to deal with this part of the question. By it we are taught that, whilst vast cataclysms must have taken place in the past, the agencies of rain and wind and sun and ice and the like which we see at work to-day, are responsible for many, perhaps even most, of the changes which we have to study. Indeed

even now cataclysms occur—on a smaller scale, no doubt, than many of those in past ages, yet of great severity—such as volcanic eruptions, shocks of earthquake, landslips, and the like. Thus we have to take into account both great and sudden changes and those other changes which depend upon the slow day-after-day operations of the ordinary forces of nature. It is neither possible nor in any way necessary to devote much space to a detailed account of the processes dealt with by Dynamical Geology. The ordinary text-books on geology will give sufficient information and will supplement the few observations which follow.

Anyone who has ever watched a boiling pot of porridge will hardly have failed to notice that, under the influence of the heat and even after it is taken off the fire, the contents undergo great convulsions. Such, on a much vaster scale, must have been what took place in the cooling down of the molten mass from which the earth has been formed. Further, as this cooling process went on—with different rapidities in different places and in different constituents—the varying tensions of different parts must have caused the surface to be thrown into folds just as an apple is as it dries and becomes shrivelled. Hence depressions and elevations, primitive valleys, seas, lakes, and mountains—waterless seas and lakes until the condensation of the vapours around the earth filled them with fluid. At the same time we may imagine that pent-up accumulations of gas and steam in the interior of the crust would at times, as they still do, burst forth in eruptions and lava-flows and cause earthquakes and other phenomena with which we are all familiar. But there was and there is a second class of movements which are even more important to understand if we are to comprehend the next chapter of geological research, namely, stratigraphy. These are the slow, gradual movements of depression or elevation which are always going on, though not perceived by the inhabitants of the earth until their results are pointed out by geologists. As a result of these movements in the past there are parts of the earth on which men walk about daily which were once covered by the waves of the sea, and places once

habitable, once even inhabited by men, now covered by the ocean.

> "There rolls the deep where grew the tree.
> O earth, what changes hast thou seen!
> There where the long street roars hath been
> The stillness of the central sea."[1]

Hence, during a period of elevation, a given tract of earth may acquire no addition of material save perhaps blown sand: nay, will suffer denudation by rain and wind, whilst, during a period of depression, it may, as a sea-bottom, be covered thickly with the rich deposits carried down by some mighty river. Thus the see-saw motion of alternate elevation and depression, with its necessary corollaries, will account for the fact that the surface of the earth is not homogeneous and uniform, but consists, as even the most careless observer can hardly fail to notice, of different materials often arranged on top of one another—like "streaky bacon," to use a homely simile. Sometimes these layers stand side by side like books on a shelf, or side by side yet obliquely, like books on a half-empty shelf: sometimes they are contorted and twisted. To study these strata is the task of Stratigraphical Geology—the second of the three divisions to which allusion has been made. Not that these two are not closely interlocked with one another, for it is Dynamical Geology which must explain to its stratigraphical sister why it is that the strata do not always lie evenly on top of one another but assume the diverse positions just indicated.

We shall perhaps understand all this better if we suppose for a moment that the Sahara were to be so much depressed and the bed of the Mediterranean so much elevated that where the desert now is there were to be a sea, and where the sea is, dry land were to exist. Fresh deposits would be laid down by the sea on what is now a sandy desert, whilst what had formerly been the bed of the Mediterranean, now dry land, would be exposed to all the processes of alteration associated with terrestrial conditions. A further process of depression in the Sahara might convert it into a brackish inland lagoon, wherein a deposit of the character associated

[1] "In Memoriam," cxxiii. This passage is said to refer to Cheltenham, once part of the bed of the "Severn Sea."

with that kind of water would be laid down. Now let us suppose that, after long ages, during which the deposits we have been speaking of had hardened into rock, the Sahara is once more subjected to elevation and becomes dry land and is exposed to the examination of geologists. In the section which they might make for the purposes of examination, they would first cut through a rock formed of the deposits laid down in the brackish lagoon. Then they would cut through the old bed of the sea. Finally, they would arrive at the sandy surface of what was the Sahara—finally, that is, so far as the stages which we have been considering, for further down there would doubtless be other stories to be unfolded. Under the conditions which we have been considering, all these strata would lie evenly and flatly upon one another just as we might lay a plank of oak on one of deal and add a third of mahogany to the pile. But now let us suppose that a violent eruption takes place through the centre of these deposits. Its force will disturb their even position, tilt them up—perhaps even to a position at right angles to that which they originally occupied—and by its terrific heat will so alter their appearance as to mask the fact that they were originally deposited in water. Hence arise what are called "metamorphic rocks."

So much, then, for the connection of Stratigraphical and Dynamical Geology. We have still to glance at the constant forces which are effecting the apparently unchanging surface of the earth every moment of every day. Of these, of course, the most potent is water in one or other of its manifestations. There are the waters of the sea constantly carving away at the shores which they surround, here encroaching, there receding, as the land undergoes the slow processes of depression and elevation of which we have been speaking, but always in either case gradually eroding the apparently unalterable rocks. Then there are the running waters—rivers and streams—carving out valleys and clefts in rocks, carrying down to the sea vast quantities of deposits which may accumulate at the mouths of rivers to form bars or deltas, and in any case must be spread in large sheets over the bed of the sea. As this matter will assume great importance in connection with the question of man's period of

occupation of the earth, it may be well to pause for a moment and consider this matter of water-formed valleys.

Everyone who has ever looked at a river will be well aware that in certain parts of its course it will be found to be fringed by beds of gravel, high and dry when the river is low, submerged when it is in flood. The pebbles, sand, and gravel making up these banks have been brought down by the river, sometimes from a considerable distance. It is the same agency which has converted them from rough fragments into the well-known "water-worn" rounded stones of greater or lesser size. Now in the case of the river Thames and indeed of many, if not of all rivers, similar banks of gravel in the form of terraces will be found lying in tiers, one above the other, but all of them far above any point now ever reached by the waters of the stream. Each such terrace marks the position of the river at a former era; and what we learn from them is that the river has been busily engaged in cutting its way deeper and deeper into its bed and removing a large part of the "chippings," which it makes during its work, to the floor of the sea. Some people have thought that by ascertaining the rate of denudation by a river to-day and by then measuring the amount of denudation which has taken place since the stream began its work, a kind of calendar of its existence might be constructed. Obviously, if this could be done, and if we could fix a spot at which a human skeleton had been laid down by some flood in the stream, we could also fix or very nearly fix the date at which this occurrence had taken place, which would be a most valuable piece of information for anthropologists. Unfortunately there are so many factors to be taken into consideration in this matter—notably differences in the supply and flow of water—that the timing of events by the means of river-erosion has come to be considered an inaccurate method of calculation, at least in the great majority of cases. There are cases—such, for example, apparently is Niagara—where an approximation to accuracy may be arrived at; but such is certainly not the case with the Thames, nor probably with the majority of rivers. However, of this more must be said in succeeding chapters.

We must next consider water in the shape of ice, an agent

of the greatest potency. It acts as a rending force by creeping into cracks as water; and then, after freezing, it exhibits that bursting power which we are painfully aware of from time to time in our water-pipes. Then, as glacier or river of ice, it has exercised an enormous influence upon the surface of the earth notably in the northern parts of Europe and America, as will be seen in the account of the Glacial Epoch which will be given in a later chapter. The full story of the work of the glaciers is much too long to narrate here, and those who would study it may be referred to the list of books given on p. 240. Here it will only be possible to say that the effects of these ancient glaciers are to be seen in the valleys which they have carved out, in the rounded and scored rocks on which they have written their signature, in the moraines or "spoil-banks" which strew the countries where they have had former existence, in the boulders or "erratics" often carried miles from their original home and left in a distant country by the melting ice, in the glacial lakes, and in many other objects which cannot here be dealt with. Finally, whilst dealing with the subject of water, one must not forget the influence of the rain, not to speak of the wind which so often accompanies it, in shaping the contour of what we poetically call the "eternal hills," forgetting or not knowing that the greater hills are often if not usually amongst the youngest features of the landscape.

By degrees the earth in the process of its cooling down became capable of supporting life and life arose. Some at least of its manifestations—when everything is considered, a surprising number of its manifestations—managed to write in one way or another their autographs on the book of stone which forms the crust of the earth. Sometimes the actual object itself remains, sometimes the object has been petrified or converted into stone, sometimes it has left a cast of itself, sometimes a footprint is all that remains to show that it was once there. But in virtue of these various kinds of evidences the third division of Geology—Palæontology—exists: this is divided into Palæozoology, which deals with animals, and Palæobotany, which has its domain in the kingdom of plants. These remains of former living things

are of course for the most part associated with what are called aqueous rocks—formations laid down by water either running, brackish and stagnant, or sea. It will be understood that a dead animal or part of one, say, the skull of an ox, falling to the bottom of the sea or a river on to a bed of mud, will gradually be covered by the same material, and when that material turns to rock will be encased in it and become what we call a fossil. Such aqueous rocks will have, of course, a totally different kind of bedding from igneous rocks which were once molten—in which one would not expect to find, and does not find, anything in the nature of life—and from metamorphic rocks in which the heat has produced profound alterations. Granite, for example, is an igneous rock and sandstone is of an aqueous character. There are many others belonging to either class, but those mentioned will be familiar to most and will serve the purpose of examples.

After this exceedingly brief sketch of the general features of geology—the chief object of which has been to impress upon the reader the immense variety of operations to which the earth, and particularly its crust, has been subjected, and the immense period of time which these operations must have occupied—we may endeavour to combine the information derived from Stratigraphical Geology and Palæontology by giving a very brief account in very general terms of the chief systems of strata recognised by geologists, with a note of the chief kinds of fossils, if any, belonging to each. For it will be found that there is a gradual development of life, not a sudden commencement with all the varieties which we see around us or can study in museums. One form succeeds another; one dies out, another survives. All these facts will assume importance from our point of view when we come to consider the question of the Days of the Creation.

As a preface to this brief sketch of the strata it is necessary to say that the dispositions differ in different parts of the world, as will very naturally be understood, and that the names by which they are known also differ. All that can be here attempted is to give a general idea of the main outlines of the systems as they exist in Great Britain, with

an occasional note of American conditions. Such a sketch will suffice to explain the purport of later chapters, and those interested in the subject can pursue it further in text-books relating to their own countries. In considering the different strata it is obvious that one can commence with the more recent formations and work downwards to the older—the plan most commonly adopted in manuals of Geology; or one can reverse the method and start with the most ancient rocks, working upwards from them to the most recent strata. For the purposes of this book the latter method will be followed as the more useful: the facts laid down will be those given in the latest edition of the "Encyclopædia Britannica."

The ARCHÆAN or EOZOIC or PRE-CAMBRIAN consists of very ancient strata underlying the oldest Palæozoic rocks. There is a vast succession of these in Canada and the Lake Superior region of the United States which have been carefully studied. The lowest of these strata is known as Laurentian. In the eastern part of Canada and in other parts, sedimentary formations, below the Cambrian, have been found to contain some obscure organisms. Archæan rocks have also been studied in Scotland and in various parts of Europe.

The PALÆOZOIC or PRIMARY rocks are divided into six groups:—

CAMBRIAN

The rocks belonging to this series display a marked uniformity all over the world and consist chiefly of muds, sands, grits, and conglomerates. There is abundant evidence of the many movements of the earth which have inclined, folded and faulted most of these rocks during the long period which has elapsed since they were deposited. They invariably retain their sedimentary characteristics, muds becoming shales and slates; sands and conglomerates, quartzites and greywackes.[1] In Britain the Cambrian rocks, as indeed their name implies, are chiefly met with in Wales.

[1] With every desire to be as little technical as possible, the use of terms hardly likely to be familiar to all cannot always be avoided nor can explanations always be given. Any text-book will clear up difficulties which are not elucidated in the account given here.

In North America there are Potsdam, Acadian, and Georgian series.

The Life of this period is interesting because the rocks belonging to it are the oldest which, so far as we know at present, contain definite and indisputable remains of living organisms. With the exception of vertebrates all the great classes of animals are represented. There was no plant life except seaweeds, and the animal remains indicate that these beds were deposited in more or less deep seas. Protozoa (the simplest forms of life), sponges, and Graptolites[1] were plentiful, but by far the most important animals were the Trilobites, which belong to an extinct order of Crustacea some species of which are as much as three feet in length.[2]

Ordovician

This group of strata, found in Wales and in North America in Utica, Cincinnati, and Trenton, includes rocks of all types of sedimentation, greywackes, grits, shales, conglomerates, and limestones. It was a period of remarkable volcanic activity in the British Isles, where masses of contemporaneous igneous rocks, lavas, ashes and tuffs were laid down, giving rise to local upheavals of the sea-floor which resulted in shallow-water conditions.

The Life includes examples of all the sub-kingdoms of Invertebrates. Brachiopods (the lamp-shells of to-day) were abundant and Crinoids (or sea-lilies), and Corals occur in calcareous deposits. Trilobites now take a secondary place and Graptolites become the most characteristic fossils. The earliest indications of vertebrate life have been found in the Ordovician beds of Colorado.

Silurian

These beds—found largely in Shropshire in England, in South Wales and in North America, for example, in the Niagara Shales—are almost entirely of marine origin and

[1] Living creatures resembling the colonial zoophytes of to-day, such as the " sea-mats " found on the beach at low tide.

[2] The Crustacea include Crabs, Lobsters, and Shrimps with other like forms, and the Trilobite, thus named from its three-sectioned body, is most nearly allied, amongst living things of to-day, with the so-called King-Crab.

consist of shales, marls, limestones, sandstones, and grits. They were mostly deposited in comparatively shallow waters and there do not appear to have been any contemporaneous igneous rocks.

The Life is marked by the fact that Graptolites appear to have become extinct during this period, whilst Brachiopods are perhaps the most characteristic fossils. It is interesting to note that these exceedingly ancient shelled creatures still exist, and in forms but little if at all differing from those of their far-off predecessors. Corals flourished during the Silurian period and often formed reefs. Organic remains belonging to the great group of fishes become abundant, the most conspicuous fish-like forms belonging to the Ostracodermi or shell-skinned fishes. Seaweeds occur occasionally.

Devonian or Old Red Sandstone

The strata of this series are of great thickness and appear to have been laid down in fresh-water lakes or lagoons. The typical rocks are sandstones alternating with layers of sandy shales and beds of concretionary limestone, all more or less coloured by peroxide of iron. In North America the Onondaga limestones are examples of the lower strata of this period and the Catskills red sandstones of the upper.

The Life presents to us as its most typical feature a variety of fishes, associated with which are giant crustaceans and an abundance of corals. Brachiopods attained their maximum development. The lake deposits furnish us with the earliest well-defined marsh-plants such as lycopods and ferns.

Carboniferous

The abundance of vegetable remains, of which carbon is the chief element, has given its name to this system. It is from the remains of the abundant vegetation of this period that almost all the seams of coal in all parts of the world have been derived. In addition to these seams the strata include limestones, sheets of hard gritstone, sandstones, and shales. The limestones were deposited in open seas, the grits and sandstones in the mouths of rivers, the coals and ironstones in estuaries and swamps.

The Life of the carboniferous period, as already stated, is mainly characterised by the abundant vegetation, and amongst the cryptogams (or non-flowering plants) were ferns, horsetails, and conifers. The carboniferous limestones are rich in marine fossils, such as corals, brachiopods, encrinites (sea-lilies), sponges, and protozoa.

Permian

The strata include volcanic and limestone breccias, conglomerates, red sandstones, limestones, shales, and marls. There are occasional boulder beds which are of very great interest, as they prove to us that during the period in question there must have been a glacial epoch.

In the Life of this period we find reptiles for the first time, though fishes and amphibians are the most important vertebrates. The invertebrates include Brachiopods and other molluscs, and the plants are closely allied to those of the Coal Measures.

The Mesozoic or Secondary rocks next succeed: the lowest of these are known as

Triassic

The rocks of this system vary in different parts of the world, being either Bunter Sandstones, Muschelkalk Limestones or the marls and gypsum-bearing rocks of the Keuper series. For example, in North America in New York, Connecticut, New Brunswick, and Nova Scotia a series of red sandstone (Newark series) contains land-plants and Labyrinthodonts (a huge form of reptile) like the lagoon type of central and western Europe. On the Pacific slope, however, marine equivalents occur, representing the pelagic type of south-eastern Europe.[1] Economically these strata are of great interest and importance as the salt-bearing portions of the earth's crust.

The Life so far as fossils go, for they are scarce, is not a strong feature of this series, since it only includes a few plants, fishes, crustaceans, and reptiles, but the Ichthyosaurus existed and there were massive forms of Dinosaurs or bird-like lizards, very largely known by the footprints

[1] "Encyc. Brit.," art. "Geology."

which they left upon the wet sands and muds: these are very abundant. The most important groups of the Invertebrates are represented, such as molluscs and cuttle fish. Perhaps most interesting of all, tiny mammals of the marsupial branch make their appearance for the first time.

Jurassic

In this system there are two marked groups of strata, Lias and Oolite. The Lias consists of thin beds of a marine formation of blue and grey limestone and dark-coloured argillaceous shales. The Oolite has alternating masses of calcareous rocks with thick beds of soft clays and marls partly estuarine, partly marine.

The Life of this period is very remarkable since there is a great abundance and variety of organic remains. All groups of plants are represented, but Cycads (allied to palms) are specially typical of this period. Stumps of trees have been found three to seven feet in height. Sponges and Foraminifers[1] are abundant as are corals and crinoids. Fishes include Elasmobranchs and Ganoids, two classes existing at the present day. The reptiles were many and remarkable, including the Ichthyosaurus, Plesiosaurus, and Teleosaurus, with the Pterodactyle, a flying form, and the Megalosaurus. Skeletons of these great creatures so long extinct are amongst the most interesting objects in geological museums.

The first examples of birds are found in the Oolitic series. Small marsupial mammals existed.

Cretaceous

This owes its name to the chalk beds which, often with flints, form one of its most characteristic features. The flints are siliceous concretions, often around sponges, sea-urchins, and the like. These and the chalk itself were laid down in quiet waters. There are also sandstones, marls, limestones, and clays.

The Life of this period is in many ways a continuation of that of the last, for we still find the gigantic reptiles and

[1] Creatures constructing microscopic shells, still in existence in almost incredible numbers in deep parts of the sea.

flying lizards, though they are on the wane. Crocodiles and fishes of many kinds, crustaceans, ammonites, nautili, the usual brachiopods, and many other invertebrates, corals, and sponges all flourish. Birds, chiefly water birds, are to be found : they are more bird-like and less lizard-like. The vegetable life is also like that of the Jurassic, and there are Sequoias with oaks in places. Insects appear, and there are still marsupial mammals, but, like their precursors, all of small size.

The Cainozoic or Tertiary rocks include subdivisions known as

Eocene,
Oligocene,
Miocene,
Pliocene,

which may be dealt with together to save space. The period of deposition of strata which followed upon the Cretaceous and terminated with the Glacial Epoch was one during which the earth's surface was steadily approaching the appearance of the present day. The strata are of great lithological variety, most of the deposits being of marine, estuarine or fluviatile origin. Volcanic and other disturbances of the earth's crust gave rise to the great existing mountain chains.

The Life of this period presents two important features to us. In the first place, we see the disappearance of a very large number of the older forms which marked the fauna of earlier systems ; whilst on the other hand, there came into existence many of the forms which we find around us to-day. The birds include many forms which have now disappeared, and so of course do the mammals which marked this period and of which more will have to be said in connection with the next.

Amongst plants, Monocotyledons and Dicotyledons now take a position of pre-eminence over Cryptogams, as is the case to-day. The climate appears to have been at first warm, but in northern latitudes gave place, towards the end of the period, to colder temperatures which led up to the Great Ice Age.

The QUATERNARY or POST-TERTIARY period subdivided into

PLEISTOCENE or GLACIAL and
RECENT, POST-GLACIAL or HUMAN

must be separately discussed, and with it must be considered certain points omitted in the above brief sketch of geological conditions. But the account of the Glacial Period and a number of other matters closely connected with geological considerations must be postponed to a later part of the book, and for this reason. As has often been said in these pages the object of this book is not to teach science to its readers, but to explain the bearing of present-day science upon religious teaching. Hence the question of Man and his existence upon the earth, which is a very small item in the geological story, is to us by far its most important portion. It follows that the question of Man and his appearance on the earth must receive very much more consideration than all the other facts of Geology, which indeed have only been so far considered as was necessary for the comprehension of those matters which are of primary interest to us here.

And so, after considering the Days of Creation and the bearing of Holy Scripture and scientific knowledge upon this matter, we shall turn our attention to what we have learnt and what we surmise about the earliest men who are known to have existed upon this earth.

Having studied this section of our subject, we may then revert to geological considerations and examine the present state of scientific opinion on the Glacial Period and on man's relationship thereto. We shall then be in a position to investigate the question of the age of the earth and the far more interesting question—to us in this book—of the age of man upon the earth.

But, it may be said, you are discussing the question of Man before you have dealt with such matters as Life and how it came into existence, of the relations of animals and of plants, of evolution and of a number of other matters of that kind. No doubt this is perfectly true, but in a general account such as this it is by no means easy to

adopt that simple and straightforward order which is natural when only geology, for example, is under discussion. It is thought that by disposing of all the geological topics, amongst which is included the advent of Man, before taking up those of a biological nature, the clearest view of the questions with which we have to deal will be afforded to the general reader, for whom these pages are intended.

CHAPTER XVI

THE SEVEN DAYS OF CREATION

THERE is perhaps hardly any subject amongst those under discussion in this book around which greater strife has raged than that which has to be touched upon in this chapter. The present writer, having no claims to be regarded either as a theologian or as one skilled in Biblical Criticism, can, of course, only deal at second-hand with these topics. He has, therefore, contented himself with paraphrasing or quoting from other authors, and especially from the writings of the Rev. Dr. Hugh Pope, from whose pen the Catholic reader receives much assistance.[1]

In discussing the relations between the account which which we find in the Book of Genesis and what we learn from Science it is in the first place necessary to be quite clear as to what was the intention of the writer of the Sacred Record. The primary intention was obviously *not* to give a scientific description of the origin of the Universe. The primary intention *was* to give an account which should clearly bring out God's plan for the redemption of the human race. Hence it tells of the creation of the Universe but specially—one might almost say only—as it relates to the creation of the world, and to that again chiefly as it relates to the creation of Man. Further, for the History of Man we may substitute the History of the Chosen Race, for that is what the remainder of the Old Testament deals with and that is what the Book of Genesis leads up to. We must take it as it was intended and must not forget for whom it was intended—namely, for a race in a primitive, pastoral

[1] The arguments and quotations are taken from his work "The Catholic Student's 'Aids' to the Bible," Old Testament. London, Washbourne, 1913.

condition who could not have comprehended a scientific account if it had been laid before them, but who were quite capable of gathering, as the simple of to-day can gather, all the information necessary for the comprehension of the scheme of Redemption with which the Bible is concerned.

Dr. Pope says (p. 192) that an examination of the account given in Genesis shows us "(*a*) that creation was conceived of as consisting in a definite series of operations; (*b*) that it is given in a more or less poetical form; thus we note the recurring formula 'and there was evening and morning, one day,' etc.; (*c*) though it is the creation of the universe which is treated of, it is yet clear that all is told from the standpoint of the earth, in other words, we are not told the story for its own intrinsic interest, nor from a purely scientific point of view—we have not a cosmogony so much as a geogony; (*d*) the account is essentially anthropomorphic, i.e. God is depicted as a man, He acts, plans, and speaks like a man; (*e*) the whole account is essentially popular, i.e. it is expressed in popular language and according to appearances; e.g. the description of the firmament. If we ask what precise doctrinal teaching is to be gathered from the account, it will seem that nothing explicitly is *taught* us in the first chapter beyond the fact that *God created all*, and that *He rested on the Sabbath day*."

This not being a theological treatise it is unnecessary to discuss at any length the findings of the Pontifical Commission for Biblical Studies, which may be studied by those desirous of so doing in Dr. Pope's work already mentioned. Here it may briefly be said that we are directed not to call in question the literal and historical meaning of facts touching the foundations of the Christian religion—such, for example, as the unity of the human race.

We are not bound to interpret everything in these chapters literally where it is obvious that the words were not used in the strict sense or that reason or necessity compel us to give up the literal sense. Even an allegorical and prophetic interpretation may at times be prudently applied.

Nor need we seek for scientific exactitude of expression, since it was not the intention of the writer of the first

chapter of Genesis to teach us the innermost nature of visible things, nor to present the complete order of creation in a scientific manner, but rather to furnish his readers with a popular account, such as the common parlance of that age allowed: one, namely, adapted to the senses and to man's intelligence. Thus the word *yom* (day) which is used in the first chapter of Genesis for describing and distinguishing the six days may be taken either in its strict sense as the natural day or in the less strict sense as signifying a certain space of time.

With these directions before us we may now turn to consider two points which especially arise—points which have been urged as obstacles to the acceptance of the Christian religion.

The first of these will not require much consideration, since it is dealt with in the last of the citations from the findings of the Biblical Commission—that is, the question of the meaning of the term "days." As long as it was held that this signified actual terms of twenty-four hours it was difficult to understand how matters were to be explained. Of course no believer in a Creator doubts that God Almighty *could*, had He thought fit to do so, have created the world just as it is, fossil remains and all, in six literal days of twenty-four hours each. It need not be said that no one believes this to be the case, since such an operation would have involved the wasteful if not absurd corollary of the production of the apparent remains of millions upon millions of living creatures which in fact had never been alive. In an unscientific age, when the words of the Bible were accepted as literally true, the first discovery of fossils did indeed produce, and very naturally produced, great difficulties in the minds of men who reverenced their religious beliefs; nor is it in any way wonderful that what we now feel to have been ridiculous explanations should have been put forward to account for what was to them a very real if only apparent difficulty. Unworthy sneers have been uttered against really great observers like Gabriel Fallopius, who committed themselves, as was observed in an earlier chapter, to what we now all recognise as a far-fetched and ridiculous explanation.

As we have seen, the absurd insinuation that this explanation was one intended purposely to deceive in the supposed interests of the Church is sufficiently disposed of by the fact, usually suppressed by disseminators of the Fallopius fable, that the real character and significance of fossils were first made known to the world by a Catholic Bishop, Nicolaus Stensen, who is justly regarded by the scientific world as the Father of Modern Geology.[1]

As a matter of fact we are quite familiar with the use of the word "day" in the Bible in a figurative sense: we have the "day of the Lord," for example, which no one ever supposed to refer to a period of twenty-four hours.

Then further there is this cardinal point of importance which we must ever keep before our minds when we are considering this matter of Creation—a point which will receive further consideration when we are dealing with the question of Evolution. This most important point is that when we are speaking of the Creator we are speaking of a Being with whom all is present and for whom there is neither past nor future. We have already discussed the difficult questions of Time and Space to some extent in Chapter X and have seen how impossible it is to form any proper conception of either of them. The late Oliver Wendell Holmes says in one of his books: "Curious entities, or non-entities, space and time! When you see a metaphysician trying to wash his hands of them and get rid of these accidents, so as to lay his dry, clean palm on *the absolute*, does it not remind you of the hopeless task of changing the blackamoor by a similar proceeding? For space is the fluid in which he is washing and time is the soap which he is using up in the process, and he cannot get free from them until he can wash himself in a mental vacuum."

We cannot think or speak of God except in a more or less anthropomorphic manner, and that for the excellent reason that we are men ourselves. Nor can we think outside the "entities or non-entities" of Time and Space. But just as we can recognise that our anthropomorphic con-

[1] See his life in "Twelve Catholic Men of Science," published by the Catholic Truth Society.

ception of the Deity, though the highest and best that we can form, is hopelessly incorrect and inadequate, so also, though we cannot understand the condition, we can fully realise that an Infinite and All-sufficient Being must necessarily be untrammelled by Space and Time. And thus we realise that to talk of "days" in connection with such a Being, and to suppose that for Him they resemble our successive periods of twenty-four hours each, is to talk of two wholly different things under the same name. We do not mistake the meaning of the words "God rested," nor suppose that the same meaning attaches to them as would attach to the same words if said about any of us.

"Hast thou eyes of flesh: or shalt thou see as man seeth? Are thy days as the days of man, and are thy years as the times of man?" says the Book of Job. This seems to sum the matter up, for as God certainly has not eyes after the manner of a man, neither are we to suppose that the "days" with which we are now concerned, whether mentioned in the first chapters of Genesis or in the Ten Commandments, are other than figurative terms expressive of periods which might be well thought of under the idea of days. "Any contradiction, then, between Genesis and geology as to the time of creation is plainly impossible, for their teaching is of a different kind. The one tells us, or may tell us, the time of creation in regard to man as measured by years and centuries; the other tells us the insignificance of this time in regard to God. And therefore, as has been well said, there is only one way in which the discoveries of science can affect this subject. By the help of science we may obtain a truer idea of the real dimensions and marvellous constitution of the universe, a truer idea of the enormous length of time during which it was being brought to its present perfection; thus obtaining also a truer idea of the eternal greatness of Him to whom the whole of this vast work seemed but the labour of a few days."[1]

And now for the second point, which relates to the actual process as described in Genesis.

In the first place, the Scriptural account is plainly and

[1] Turton, "The Truth of Christianity," London, Wells Gardner, 8th ed., p. 142.

distinctly monotheistic, and in this respect it differs from some of the other ancient mythologies, which are polytheistic. The Assyro-Babylonian accounts "are frankly, nay grossly, polytheistic," says Dr. Pope, "whereas the Biblical account is purely monotheistic. Again, the Assyrian account does not seem to involve a creative act; the light, for instance, is rather the result of a conflict between two powers, an evolution rather than a creation, and we are reminded of the dualism of the Persian Zoroastrianism. It is particularly noticeable how the Assyrian story personifies the Chaos of the Bible; Tiamat is a deity, or at least a principle of evil. This is part of that metaphorical presentation of things which we indicated above when treating of myths; but the Biblical account is absolutely free from it. Once more, as Prof. Sayce has well remarked, 'between Bel-Merodach and the Hebrew God there is an impassable gulf.'"[1]

In the next place, it is very distinctly stated that the process was gradual. The account might very well have stated that God created the universe and all that was and is in it and have ended with that statement. It would have been a perfectly correct statement, so all Christians believe; but that which is given to us is more detailed, for it informs us that first one and then another thing happened, and the sequence of these events is sketched for us in the form of days. There is a sequence: that is clear, and we have now to see how far it fits in with what science tells us on the subject.[2]

(i.) "In the beginning God created heaven and earth" (Gen. i. 1). We have already discussed the question of Matter and shall again have to touch upon some of the views which are held about it, and we have seen that in the opinion of eminent physicists there is no alternative between the two theories—that Matter was created and endowed with its powers by God or that it is eternal and alive. The former is the view which the late Lord Kelvin

[1] Pope, *op. cit.*, p. 197.

[2] Though it is useful to commence the consideration of the "Seven Days" with the chronological discussion now to be undertaken, it must be taken in very strict relation with the statements contained in the next chapter.

stated to be that demanded by science. It is certainly that which all Christians hold, and we shall venture to argue that from the standpoint of mere reason it is infinitely more credible than the other. If that be so it is obvious that, since all things are formed from matter, it would be the first thing to come into existence and from it would be formed the heavens and the earth, that is the universe.

(ii.) "And the earth was void and empty, and darkness was upon the face of the deep" (Gen. i. 2). Here again the account exactly tallies with what science tells us to have been the case. The earth having been formed from a nebula in a state of intense heat and requiring a long time in order to cool down to the point at which living matter could exist upon it must, during that time, have been void and empty of living things. Moreover, everything seems to point to the fact that during this period it must have been surrounded by dense clouds of vapour, afterwards to condense into the seas and waters of our planet, vapours which would cut off from the earth, as it then was, any rays of light which it might otherwise have received from the glowing nebular masses of the universe.

(iii.) "And God said: Be light made. And light was made" (Gen. i. 3). This is a point as to which some remarks must be set down. In the first place it may be pointed out once more that the whole account of the Creation centres round this earth of ours and is not necessarily or reasonably to be expected to contain a minute narrative of the universe and its formation. The statement as to the darkness in the previous verse certainly and admittedly relates to the condition of the earth. It would appear that the statement as to the light does the same and that it gives us to understand that the next stage in the proceedings was the letting in of the light upon the previously dark earth, which would occur when a condensation and precipitation of the dense vapours surrounding the earth had taken place.

But where was this light derived from, since we are told that the sun and moon and stars were not yet in existence? This is a very remarkable point and one which bears out the accuracy of the Biblical account in a very striking and unexpected manner. At the time that it was written, and

for many hundreds of years afterwards, no one knew anything about the Nebular Theory, and it might have been argued that it was patently absurd to suppose that light could have existed before the existence of those bodies from which we now receive it. The Nebular Theory, however, clears up this difficulty, for it teaches that our solar system, which is all that the Biblical account is directly concerned with, at the period in question, was composed of whirling and as yet imperfectly condensed masses of nebular substance. In the case of the sun, on account of its size, the condensation would take longer than in the case of the earth. It would still be incorrect perhaps to speak of it as a *sun*, but it was a source of light, as were any other nebular masses which might have been in existence. It is certainly remarkable, as far as we have got, that the Biblical account and that of science present no contradictions. That is what we, as believers in Revelation, would expect, but we may reasonably ask of those who do not believe how they account for the fact that such a near approximation to what science believes to have occurred should have been reached, seeing that no human eye saw, nor could any human mind, one would imagine, guess at these far-off occurrences.

(iv.) "And God said: Let there be a firmament made amidst the waters: and let it divide the waters from the waters" (Gen. i. 6). The note in the Douay version very clearly explains what is meant by this saying, for it runs: "*A firmament.* By this name is here understood the whole space between the earth and the highest stars. The lower part of which divideth the waters that are upon the earth, from those that are above in the clouds." We have already seen that the process of condensation, by which the waters around the earth in a state of dense mist were deposited on the cooling globe to become its seas and lakes, was one which would take place when the earth had sufficiently cooled and would be accompanied by the falling of light upon the hitherto dark surface of the planet.

(v.) "God also said: Let the waters that are under the heaven be gathered together into one place: and let the dry land appear" (Gen. i. 9). From this we learn that at

one time there was no such thing as a patch of dry land on the surface of the earth, but that all was water—a thing which no one would have been likely to have guessed or even expected but which science is very far from denying. On the contrary, it seems at least quite possible, from what science infers, that this was exactly what did happen: that the earth was at one time completely covered with water and that subsequent elevations of parts of its surface, accompanied by depressions of others, led to the collection of the waters into isolated localities forming the seas and lakes of the primitive world, with dry land now emerging from them.

(vi.) "And He said: Let the earth bring forth the green herb and such as may seed, and the fruit tree yielding fruit after its kind" (Gen. i. 11). Here we have the appearance of vegetation and in its right place, for though low forms of invertebrata seem to accompany the earlier forms of vegetation known to us, no one denies that the vegetable kingdom is more primitive than the animal, nor that in the process of evolution one would expect plants to appear before animals. Here again, however, it is fair to ask how an uninspired writer was likely to have made the lucky guess that plants came before animals.

There is, of course, a point which must not be passed over here without comment. The Scripture clearly alludes to all kinds of plants and makes very special mention of Phanerogams or flowering plants which, as we have seen, did not come into existence until long after other and, in the Biblical account, later events. Here again we must revert to the principles laid down that the account is an outline, mainly intended to represent the work of the Creator in His creation and is singularly abbreviated. From the evolutionary point of view the account is remarkably correct, for *ex hypothesi* plants having first arisen as very lowly Protophytes, passed through Cryptogams into Phanerogams and, since the higher were involved in the lower forms, may all have been said to have been created at the same time. This is a matter which will have further to be dealt with when the question of Evolution comes under discussion and it may be left where it is for the

moment with the remark that the Scriptural account, properly understood, does not contradict in any way what science believes to have been the case as to the order of the appearance of living things. We note, however, that we have arrived at a very important milestone in the history of the world, that of the introduction of life, a new principle which in its higher manifestations was profoundly to modify the world of inanimate matter.

(vii.) "And God said: Let there be lights made in the firmament of heaven. . . . And God made two great lights: a greater light to rule the day; and a lesser light to rule the night: and the stars" (Gen. i. 14–16).

Reference has already been made to the question of the appearance of light before there is any mention of the sun, and on this matter a quotation from a work already referred to may be permitted. After speaking of the Nebular Theory and the removal of the obstacles to the permeation of light presented by the thick vapours which surround the earth Col. Turton continues[1]: "If it be urged that on this view the sun was not actually created on the fourth day, but had merely by that time sufficiently contracted to become a *great light,* and that Genesis ought to have implied this, the answer is obvious. It is precisely what Genesis has done. The original creation of the sun is described in verse 1 under the term *Heaven;* and when we are told later on that God *made* two great lights, the other word is used, which as before said, means evolved or fashioned, and which would be quite suitable for the gradual formation of a sun from a nebula.

"Two objections have now to be considered. The first refers to the *moon,* which must have been thrown off from the earth long before the dry land and the vegetation appeared; and being so small, would have consolidated sooner. But when considered only as *lights*, as they are in the narrative, it is quite correct to place the moon with the sun; since moonlight is merely reflected sunlight. And, therefore, before the sun contracted so as to give out a powerful light, the moon could not have shone very brightly either.

[1] "The Truth of Christianity," p. 154.

"The second objection is, that according to Genesis, the earth seems to be the centre of everything, and even the sun, or at all events its light, exists solely for the sake of lighting the earth. Now no doubt the writer takes for granted the great importance of the earth; but as far as *man* is concerned—and the narrative was written for him alone—it is quite correct to do so. And as to the object of sunlight: we know that it is of use to the inhabitants of this planet, and we do not know that it serves any other useful purpose whatever.

"These, however, are but minor matters; the important point, as before said, is that the writer of Genesis places the formation of the sun *after* that of light. This must have appeared when it was written, and for thousands of years afterwards, an obvious absurdity, since everyone could see that the sun was the source of light. We now know that it is correct. But is it likely that the writer of Genesis had any human means of knowing this; or is it likely that, without such means, he should have made such a wonderfully lucky guess? Either alternative seems most improbable, and yet there is no other, unless we admit that the knowledge was divinely revealed."

(viii.) "God also said: Let the waters bring forth the creeping creature having life, and the fowl that may fly over the earth under the firmament of heaven. And God created the great whales and every living and moving creature which the waters brought forth, according to their kinds, and every winged fowl according to its kind" (Gen. i. 20, 21).

Here we arrive at the second milestone in the path of progress, for not only do we find ourselves confronted by life but for the first time with sentient life, and, as already said, it is described at the place where science tells us that it might be looked for. Now here we have another agreement between the Scriptural and the scientific accounts, for the evolutionist will certainly not deny that zoological life seems first of all to have originated in the sea; that it was preceded by the appearance of vegetable life; that fishes did come before birds and that the gigantic saurians—which it is suggested may have been intended by the

Hebrew word commonly but probably incorrectly translated "whales"—were a very remarkable feature of the period of geological time at which we have now arrived, since some of them attained a length of at least fifty feet. It has also been pointed out that it is somewhat remarkable that the writer, of course unfamiliar with science, should have grouped birds with fishes and not with mammals, which would have seemed much more natural. Yet in doing so he is acting quite correctly.

It cannot, however, be concealed that the narrative at the point at which we have arrived leaves one difficulty to be cleared up. In our sixth sub-division we arrived at vegetable life and now in our eighth for the first time we come upon animal life. Yet, on the other hand, as far as known, invertebrate life, of a low form no doubt, has existed upon the earth as has life of a purely vegetable character. According to the evolutionist—though this is a theory, not an established or perhaps even an establishable fact—life appeared as a single-celled organism of an indefinite character which diverged on the one hand, into protophytes, or early vegetables, and on the other into protozoans or early animals. This surmise, even if correct (which is quite unproved) would still, from the philosophical point of view, leave the plant form the earlier of the two. For the essence of the animal form is that it has something more than the plant form, namely, sentience of some kind or another. The indifferent form, if we can conceive of such a thing, cannot have possessed sentience, therefore it was not an animal. But if it did not possess sentience and yet was alive it must have been a plant. This argument would lead us to believe, on the evolutionary hypothesis, that animals had been derived from vegetables and that the latter were, as the Scriptural account makes them, the older of the two.

Still the animal kingdom is apparently placed at a greater distance from the vegetable than one would expect, and perhaps the explanation is that the account does not trouble itself with what would, to those for whom it was intended, seem quite insignificant creatures and makes straight for those forms of animal life which would seem

to be and really are of first importance as factors amongst the fauna of the earth. One always has to bear in mind the compressed nature of the account and the purpose for which it was written. When these are allowed for there certainly is nothing very wonderful in the omission, if omission there be, of any notice of the invertebrate animals.

(ix.) "And God said: Let the earth bring forth the living creature in its kind, cattle and creeping things, and beasts of the earth according to their kinds" (Gen. i. 24).

Here again we find the land-animals placed in their proper position, for they certainly came into existence after fishes and birds and before man—that is, taking them as a whole. There were a few marsupials as early as birds, but mammals only come into real importance in the Tertiary period, so that the statement is quite correct in a compendious manner.

(x.) "And He said: Let us make man to our image and likeness" (Gen. i. 26). Last of all man appears, and last of all he is described as appearing. Much consideration will be given to the time and manner of his appearance in later chapters: here we need only advert to the fact that he is found in the place where science tells us that he should be found.

And now, having considered the account in Genesis, we may pause to consider whether on general lines and apart from the question of Revelation, there is not a remarkable similarity and agreement between the Scriptural narrative and the findings of science. Romanes once wrote,[1] "The order in which the flora and fauna are said, by the Mosaic account, to have appeared upon the earth corresponds with that which the theory of Evolution requires and the evidence of geology proves." This statement cannot be gainsaid, and we may usefully bear in mind that "the points of agreement between Genesis and science are far too many and far too unlikely to be due to accident. They are far too many; for the chances against even eight events being put down in their correct order by guesswork is 40,319 to 1. And they are far too unlikely; for what could have

[1] "Nature," 11th August, 1881.

induced an ignorant man to say that light came before the sun, or that the earth once existed without any dry land ?"[1]

On this matter Dr. Pope (*op cit.*, pp. 196, 7) says : " Primitive nations must necessarily have attempted to give some explanation, however unsatisfactory, of their own existence. It is hardly to be supposed that different nations would have lit upon the same metaphorical way of expressing their ideas on this subject.[2] And it seems perfectly legitimate to argue that the universal witness of the world, especially as concretised in the records which we have been examining, bears witness to a primitive revelation on the subject of the origins of mankind and the world in general. At the same time this revelation, while coming from God to man, must necessarily have been expressed in language suitable to man's comprehension, and he, in handing down to his sons the revelation received in the beginning, must needs have expressed things which, save in the case of Adam himself, were beyond his power to understand, and indeed altogether beyond his experience, in terms, too, which were often little better than metaphors, and which as such were only to a small extent capable of giving expression to man's ideas on the subject ; it is in this sense that we can speak of the stories in Genesis as myths or legends, and in no other. In doing so we do not cease to remember their divine origin ; we look rather at the halting way in which, from the necessities of the case, they must have been expressed. . . . What, then, are the relations between these Assyrian and pre-Semitic accounts and the Biblical narrative ? It must be remembered that the Assyrians, Babylonians, and Hebrews, were, all alike, Semites ; further, that the parent of the Hebrew race, viz. Abraham, had come out of Chaldea, and that at the Exile the Hebrews had returned thither. The advanced Rationalistic School would argue that since the Pentateuch, according to their ideas, is only to be referred in its present form to the period succeeding the Exile, i.e. to about

[1] Turton, *op. cit.*, p. 163.
[2] He has just been discussing the Assyrian and the Babylonian accounts of creation and showing their relationship to that of Genesis.

400 B.C., we must see in the account of the Creation preserved in Genesis nothing more than a myth derived from Babylonia during the time of the Captivity. Others, however, would hold that the Hebrews derived it from Chaldea, in the period preceding the departure of Thare from Ur of the Chaldees, and that they preserved the original story in its monotheistic form, free from the accretions we now find in the Chaldean tablets. It is, however, a striking fact that the Bible represents to us Thare and Abraham as believers in the One True God, and it would seem as though, from the days of Noe, God had preserved for Himself a portion of the human race untainted by the prevailing idolatry. He had revealed Himself to Adam and again to Noe; yet it is implied all through this early period of the history, that in spite of the defection of the vast majority of mankind, there was always a chosen seed which did not stand in need of new revelation of what had once been declared, though it did at all times call for drastic purification from the errors which had inevitably crept in through contact with the unbelievers in whose midst they lived. It would seem, then, more in accordance with the facts to suppose that all along the course of the history the true account of God's dealings with man and of His formation of the world and of the human race had been preserved undiluted and was handed down from century to century. Indeed, when we come to reflect upon it, a purification of the Chaldean account of the Creation or of the Flood would have involved an almost radical change of the accounts."

CHAPTER XVII

THE SEVEN DAYS OF CREATION—*continued*

IN the foregoing chapter we have sought to indicate the striking concordance which exists, even chronologically, between the Biblical sketch of the creation of the world, considered as a statement for the people, and the teachings of the most modern science as to its origin. But since it is unhappily most true that a widespread ignorance as to the true attitude of the Church on such matters prevails, it becomes of the first importance to emphasise the fact that the propositions laid down in the foregoing chapter are by no means the only view set forth by Catholic authorities on this difficult question.[1] That the ignorance just alluded to exists, and exists even in places where it should not, and where it would scarcely be suspected to exist, is exemplified by the fact that Renan, who ought to have known better, wrote: [2] "To deny that several portions of Genesis have a mythic character, obliges me to explain as real, accounts such as that of the terrestrial paradise, the forbidden fruit, Noah's ark. Now one is not a Catholic if on a single one of these points one departs from the traditional thesis." On which Mgr. Vigoroux remarks,[3] "M. Renan is more exacting than the Church, for it is false to assert that a person ceases to be a Catholic if on a single one of these points he departs from the traditional thesis. For example, it is not of faith that we must understand in its literal sense all that which is contained

[1] It is only fair to say that for the opinions set forth in this chapter I am indebted to the kind assistance of the friends whose names have been mentioned in my preface.

[2] In his "Souvenirs d'enfance," p. 293.

[3] "Mélanges Bibliques: La Cosmogonie Mosaïque," 1889, ed. 2, p. 517, n. 2.

in the first chapter of Genesis, whatever may be the universal opinion of theologians. Some commentators, among others Cardinal Cajetan, interpreted allegorically the beginning of Genesis, and the Church has not condemned them but has continued to regard them as Catholics."

There has always been a great diversity in the Church as to the interpretation of the first chapter of Genesis, over a dozen methods having at one time or another been suggested by different Catholic theologians without any disapproval from the Church. From the very start there was a strong exegetical school which refused to take the account of creation with chronological strictness. The Jewish commentators Aristobulus and Philo, the Christian Fathers Theophilus and Justin, and most of the Alexandrian Fathers upheld a simultaneous creation and interpreted the six days as an allegorical description of the order and development of the universe. In other words, these Fathers explained Genesis in accordance with the then current philosophical and scientific views. Later on the Syrian School of exegesis arose in opposition to the excesses of Origenian allegorism; these exegetes, less deeply versed in the natural sciences, took a more literal view of Genesis. But neither interpretation has been canonised, and at the present day many different views prevail. For instance, there are Catholics who hold that the "seven days" are merely an arrangement of the creation for purposes of liturgical recitation.[1] There are many Catholics (notably Hummelauer, Hoberg, Schopfer) who interpret the "days" as stages of a vision. According to this view, Moses had a vision of God's creative power, a series of dissolving views in which the pictures succeeded one another, so that darkness closed in on one, and then the next brightened up before the seer's gaze.

This form of allegorical or ideal explanation is, indeed, perhaps the most common at the present day. It starts from the suggestions of St. Augustine and abandons all effort at the periodistic harmonising, since, according to such views, the Scriptural account is not to be deemed at

[1] Bishop Clifford, "Dublin Review," April, 1881.

all a chronological account of successive events, even in the roughest outline.

Another form of explanation is that the Scriptural account is an allegorical drama in six acts in which the religious duty of worship of One God who has created the world and gratitude for the magnificent bounty of that creation are inculcated.

By others again it is conceived as an Epic or grand moral narrative, presenting picturesquely facts and events grouped in categories convenient for the ethical purpose of its author. Thus the story of the Victorian Era might be given as "The Days of Victoria" in six cantos or chapters. These might each narrate in detail the events of successive decades of that prolonged reign. Or the separate sections might be allotted to groups of kindred facts, as Foreign Wars, Constitutional Changes, Social Development, Progress of the Nation in Wealth, Art, Literature and the like. Or successive chapters might describe features of her domestic life, her public life, her relations with British Statesmen, with Foreign Monarchs, her tastes and habits and so on. Any of these or other methods might be followed according to the purpose of the author and the work might be truthful, logical, and historical, although the chronological presentation of the subject matter would vary indefinitely.

The work must be understood according to the object of the writer.

It is not intended here to argue for or against any or all of the methods of interpretation set forth in this and the preceding chapters. The diversity of views is emphasised to guard against any undue dogmatism or any attempt at a premature "reconciliation" of Genesis and Science. Our present geological notions are as different as can be from the Neoplatonism of the early Fathers, or from the cosmogony of the mediaeval Schoolmen. Yet Genesis has been "reconciled" with each of these systems. It is certainly a laudable effort to show that the Mosaic account tallies with the chronological development of the earth as we now conceive it. Yet I wish to make it clear that in commencing —as one must commence somewhere—by discussing that method of apologetic I by no manner of means desire to

press it too far. There are many warnings against such a policy. "It has seemed to me," writes Cardinal Newman, in his "Apologia," "to be very undignified for a Catholic to commit himself to the work of chasing what might turn out to be phantoms, and, in behalf of some special objections, to be ingenious in devising a theory, which, before it was completed might have to give place to some theory newer still, from the fact that those former objections had already come to nought under the uprising of others."

This is the opinion of a theologian, to which it may be well to add that of an eminent man of science. Bishop Ellicott wrote in 1876 to Clerk Maxwell (who, be it remembered, was the originator of the electro-magnetic theory of light), to consult him concerning the apparent creation of light before the sun. This was his reply,[1] "I should be very sorry if an interpretation founded on a most conjectural scientific hypothesis were to get fastened to the text in Genesis, even if, by so doing, it got rid of the old statement of the commentators which has long ceased to be intelligible. The rate of change of scientific hypotheses is naturally much more rapid than that of Biblical interpretations, so that if an interpretation is founded on such an hypothesis, it may help to keep the hypothesis above ground long after it ought to be buried and forgotten."

In the light of these remarks it is well not to build too exclusively on the interpretation of *Yom* (day) as a geological period. There are many difficulties in such a view, not the least being the appearance of plants before the sun. And, even if this exegesis be correct, we must never forget the plain meaning of a text written for a primitive people. The author of Genesis wished to enumerate God's creative activity in some orderly framework, and the week naturally presented itself as a ready-made and sacred standard of enumeration. We have already seen that it is not necessary to regard the scheme of sub-division as chronological.

Perhaps an even simpler and more likely scheme is suggested by Genesis ii. 1: "So the heavens and the earth were finished and all the furniture of them." The funda-

[1] "Life of Clerk Maxwell," p. 394.

mental idea of the word *tsebhaam* (which St. Jerome should have translated not by *ornatus* but by *exercitus* as elsewhere) is motion or movement. According to this the six days are occupied with :—

(i.) Regional preparation.

(ii.) The corresponding moving or living inhabitants (" all their armies.")

Then the scheme of days would stand thus :—

REGIONS.	1. General preparation—light. 2. Expanse (for stars) and air (for birds). 3. Land and plants (for animals) and sea (for fish).
INHABITANTS.	4. Stars. 5. Birds and Fish. 6. Animals and Man.

The ancients considered light as independent of material radiators. This is why light is described before the stars ; this also explains how Job (xxxviii. 19) could ask in what hidden place light dwelt.

The plants are described on the third day and no blessing was given to them such as was given to fish and animals. To antiquity the life of plants did not seem at all comparable with that of animals ; generation too seemed very mysterious, but it appeared much less surprising that plants should produce seeds.[1]

When we thus examine the account of Genesis in its pristine historical setting, its true beauty and truth stand out quite independently of any preoccupation with contemporary science.

The details are those of any primitive people with a naïve outlook upon nature ; for instance, the firmament (*raqia*) was conceived as a solid support for the upper reservoir of waters.[2] But, as we have already stated, the real lesson of Genesis was religious ; it teaches a pure and uncompromising monotheism. The sun and moon are not deities (as with the Babylonians and others) but simply lights (*meoroth*). The primitive void and waste was not caused by

[1] Compare St. Thomas, " Summa Theol.," i., q. 69. a2, ad. 1.
[2] Compare Exodus xxiv. 10 ; Job xxxvii. 18 ; Psalm cxlviii. 4.

demons; chaos (*tehom*) is itself God's creature, unlike the Babylonian *Tiamat* which was a dragon.

"In the beginning God created heaven and earth." "Many," says St. Augustine,[1] "dispute much about those things which with greater prudence the sacred authors omitted. . . . The Spirit of God who spoke through them did not wish to teach men those things which were of no avail for salvation." This advice is still opportune to-day, and so is that contained in the following passage by the same Father:[2] "In things that are obscure and remote from sight if we read anything even in Scripture which with safety to our Faith can bear different meanings, let us not by precipitate assertion so throw ourselves into any one interpretation as to be ruined in case a fuller investigation of the truth should overthrow our view. This would be to fight, not for the meaning of Holy Scripture, but for our own meaning, so that we wish to impose our own meaning on Scripture when we ought to wish to make the meaning of the Scripture our own." This part of the subject may be concluded by the following extract from the writings of a modern theologian:—

"All that the Church asserts is the unity of the human race, all descended from one ancestor, all born in original sin through the transgression of that ancestor, and all in need of the redemption of our common Saviour. Of course, the Church also asserts whatever is meant and asserted by the narrative of Genesis. But the Church has afforded us no authoritative interpretation of that most obscure narrative. No theologian will undertake to say who were the inhabitants of the *city* that Cain built (Gen. iv. 17). . . . The Church, I say, is silent on the subject; and from my own private searching of the Scriptures, I do not gather anything to settle the question whether the primitive races of mankind, as races, were savages or not. Thus we are referred back from the Bible record to anthropology."[3]

[1] "De Genesi ad literam," ii., 9, 20. [2] *Ibid.*, i., 18, 37.
[3] Joseph Rickaby, S.J., "Political and Moral Essays," pp. 177 *seq.*

CHAPTER XVIII

EARLY MAN—SOME PRELIMINARY CONSIDERATIONS

WE have now to take a long step in advance and—leaving aside for the time being all considerations as to the nature and origin of life and the development and origin of species—must, for reasons already given, turn to the consideration of what kind of an individual early man, as shown to us by scientific observations, actually was. As he existed ages before history came into being, it must, to many people, seem difficult, if not impossible to know anything about him of any certain and definite character; but this is far from being the case.

Even to very remote ages—almost if indeed not quite the remotest in which it is known that man has existed—science has penetrated and has unveiled some at least of the mysteries which hang around human existence at that period. There are two classes of relics of early man on which we have to rely in forming an opinion of the kind of person that he was. We have, in the first place a certain number of actual remains of the human beings themselves, that is their skeletons either entire or in part. Of the very earliest men we may perhaps have no remains at all, and in any case what seem to be the earliest in our possession so far, are, as will later on be shown, sometimes problematical in character and difficult of explanation. Then, as we come to later though still very remote ages, the number of specimens increases, so that we can speak with considerable certainty as to the appearance of the former owners of the skeletons and even divide them, with some approach to accuracy, into distinct races. Much more will have to be said under this heading at a later point in this discussion; for the present we may leave the bodily relics of prehistoric

man and turn to the second class of relics, viz. his implements, which have afforded so much valuable information.

It is most probable that the earliest implements utilised by prehistoric man, being mere natural fragments of rock, of wood, of horn, or of shell, are, even if they have persisted to the present day, wholly undistinguishable from similar objects which have never been utilised by man. Even the first implements on which he exercised his ingenuity must, one may surmise, so closely have resembled natural objects as to be almost unrecognisable as the work of man's hands. And indeed we shall see that great disputes have raged around the case of certain stones claimed by some as the works of man's hands and denied that position by other and no less competent authorities.

At last, however, we do arrive at implements which all persons competent to form an opinion agree to be the work of man's hands, and at that moment the science of Prehistoric Archæology comes into being. We may now consider briefly its method and its limitations. The first question that any intelligent enquirer would ask about the implements of which we have been speaking is this: How do you know that they are the work of man's hands? When the palæolithic implements discovered at Abbeville in France, about the middle of the last century, by Boucher des Perthes, were first made known to the scientific world, this was exactly the question that was asked, and it may be added that it was answered in the negative by many authorities. Gradually, however, scientific opinion came round to the view of the discoverer of these objects, as to the nature of which no one now has any doubts. A very similar series of events occurred in connection with the so-called Eoliths but with a different result, since, as will shortly be detailed, the general drift of scientific opinion is opposed to the acceptance of these objects as artefacts.[1] The reply to the question asked above is that a very great number of the relics of prehistoric man could not by any possible means have come into existence by the processes of nature, nor could any sane person mistake them for

[1] This term may be compendiously employed in place of the longer expression—"the work of man's hands."

anything but what they are, the works of man. Such, for example, is the case with all the bronze implements, with prehistoric pottery, with a host of other things.

But, of course, it is with the earlier implements that the difficulty arises, and that for the obvious reason that they more or less closely resemble purely natural objects, so that the first and most important question that has to be answered in connection with any doubtful implement is this: Could it have been produced by the ordinary forces of nature such as water, ice, lightning, and so forth? If the reply to this is in the affirmative, then, though the object may be an artefact, we cannot feel sure that it is so. If the answer is in the negative and it seems quite certain that no process or combination of processes of nature could possibly have shaped the object, then, by a process of elimination, it must have been made by man. There is another means of study and identification of the nature and purpose of the implements we are discussing and one very important to understand. Prehistoric Man was a savage, a primitive being, like the savages of to-day or of yesterday; his needs were identical with those of the latter-day savage, and, his mind working on precisely similar lines, he met these needs as the modern savage met them before civilisation came across him and led him to alter his methods. Hence the implements of the earliest kinds which come under our study are quite similar to and in some cases absolutely identical with those which primitive races are now making and using, or were making and using up to a very recent date.

Therein lies the reply to the second question which one may expect to have propounded by the same intelligent enquirer: You call these things adzes, borers, arrow-heads, scrapers, and so on: how do you know what they are? The reply is that all these things, and many others, are identical with objects now made and used for the purposes indicated by their names, by savage tribes.

Let us take one very obvious instance, that of the stone arrow-head. Even a person who had never heard of prehistoric men would, if shown one of these objects picked up, let us say, on the Wiltshire Downs, have no kind of doubt

what it was. It would be instantly recognised as an arrow-head, and a person of the ignorance postulated would confine his wonder respecting the object to the selection of such a material as stone when metal was presumably to be had.

But let us suppose that it was not so impossible to mistake the purpose of the stone arrow-head ; even then there could be no difficulty, for it is strikingly like the same object as manufactured in historic times, and to our quite certain knowledge all over North America by the Indian tribes. The tiny and beautiful arrow-heads, for example, found in Oregon are, though smaller than most of such objects, otherwise identical with similar implements found in England, in Ireland, in various parts of Europe, in Japan, in fact the world over. The common stone axe found in Australia is the own brother of the same implement found in Ireland ; the adze-head of stone dredged up from the Thames differs in no remarkable respect from that found on the other side of the world. A remarkable example of this is to be met with in connection with the primitive pottery, made of course on open hearths and not in closed furnaces. Take a pot manufactured by those very primitive people the Akikuyu, whose country has lately come into prominence in connection with a strenuous religious controversy. Place it beside a pot made by the prehistoric inhabitants of the Wiltshire Downs during the Bronze Age. No one but an expert could decide which was the ancient and which the modern product. Such being the case, it is allowable to conclude that the method of manufacture of the two articles was not very different, and as we know step for step the exact method of the manufacture of the Kikuyu urn we can form a pretty good idea of how the far-off denizen of what is now Wilts made his domestic pottery.[1] So that by this comparative study of ancient and modern artefacts we are not only able to decide as to the character and uses of the former but also to obtain an accur-

[1] The reader will find a most interesting account of the ways and methods of a primitive race in Mr. and Mrs. Routledge's book "With a Prehistoric People," which deals with the Akikuyu. London, Arnold & Co., 1910.

ate impression of the very ways in which they were made and used.

There is another interesting method of study of which some mention must be made. No important object exists which is not the result of a certain amount of evolution or development. Take the modern motor bicycle. Everybody who has attained to middle age can remember the "bone-shaker" and how it developed into the high bicycle, the "Ariel," for example, which again disappeared to make room for the so-called "safety," the "push-bicycle" of to-day from which has developed the motor bicycle which buzzes along our roads. In a similar manner, but in ages long past, the hollowed-out stone was used as a lamp, with perhaps a tuft of moss sticking out at one corner for a wick and fed by sea-blubber or some such kind of fat. Such a lamp is used by the Esquimaux of to-day, and such a lamp is to be picked up amongst the remains of prehistoric habitations. From this was developed the common earthenware lamp, at first open, then closed save for wick and oil-holes, the kind of lamp often called a Roman lamp, but really common to the whole Mediterranean shorelands; the kind of lamp of which our Saviour was thinking when He spoke the Parable of the Ten Virgins. In time this became constructed of metal, and we have the Scotch "Cruisie," still, I believe, in use in out of the way parts of North Britain. A derivative is the common brass many-wicked lamp used in Italy from which comes the old "Moderator" and the common paraffin lamp used where gas and electricity are unattainable. What we learn from all these methods of study is that Man is—and as far back as we can trace him, Man has always been—Man; possessed of similar needs and meeting those needs by similar inventions; similar—nay identical—in mental processes.

We may now turn to a third question—the last to be propounded by our intelligent enquirer. It may thus be formulated: You tell us that such and such an object was made ages ago by some long-forgotten prehistoric man and was not made by nature, and that it was made for such and such a purpose, and all this you seem to have made good. But you then proceed to tell us something

about his ideas, and even his religious ideas; pray what grounds have you for such conclusions? The reply to this most natural question is deducible from what has been said, and may thus be summed up: Wherever and whenever we find him, Man is in all respects the same kind of individual. We are not for the moment alluding to his physical characteristics, though, as will shortly appear, very much the same may be said about them; what we are alluding to is his general outlook upon life, his general response to the common needs of humanity. In all these matters, right back to the beginning of history, Man is Man and nothing else: and we are, therefore, entitled to argue from primitive man of to-day with his remains and his ideas to primitive man of the earliest ages, whose remains are so very similar and whose ideas can therefore hardly have been so very dissimilar.

Let us take the most remarkable example of all, doubly interesting for the purposes of this book. Prehistoric archæology teaches us that there never was a time, from that of the earliest known interment of the remains of the dead, when man did not believe in a Future Life, in what we call the Immortality of the Soul, though his psychological range did not, we may assume, lead him into any very great subtilty of consideration in connection with that matter. How can we prove this statement? Well, there is nothing more certain than that savage races, the world over, bury food, arms, ornaments, and such-like objects with their dead with one idea only—namely, that the spirit of the dead person may make use of them in another world. Further, with a curious kind of logic they sometimes argue that, since the spirit of the dead person cannot go into the other world until the person is dead, so neither can the spirit of the implements accompany their master unless they also have been killed, and so they are broken as the surest method of killing them and releasing their spirits. It is, of course, for this purpose and that they might wait upon their master in the other world, as they had done in this, that slaves, horses, and such-like living creatures were slain at their master's funeral and their remains buried with his.

There is no contesting these facts, nor has anyone ever desired to contest them, since the evidence is overwhelming. Now we find precisely the same facts obtaining with regard to prehistoric man. The very earliest interment so far discovered is that of Chapelle-aux-Saints in France, of which more will be said in another chapter. In this interment, dating back no one can say how many thousand years, we find precisely the same conditions obtaining. With him, too, were buried the "Grave-goods" or "Accompanying Gifts," in this case flint knives and bones, which were provided by those who survived him for the use of his spirit in another world. The idea of that other world is no doubt crude enough, but it is there, and its conception is on a level with the conceptions which in all probability these people formed concerning other matters. For example, pieces of red ochre were placed with the remains above alluded to. It is a common habit for savage races to decorate their bodies with this substance, no doubt a foolish and perhaps even unbecoming habit, but not so very far removed from the rouge and powder of persons who would regard themselves as the *dernier cri* of civilisation. We may feel quite clear that in the case of prehistoric man the ochre was placed with the dead body in order that its former owner might not appear undecorated in the spirit land. Further, bones were placed over the head—in fact, as Professor Sollas[1] observes, "this was evidently a ceremonial interment, accompanied by offerings of food and implements for the use of the deceased in the spirit world." Nor will anyone be disposed to cavil at the way in which he comments on these facts when he says, "It is almost with a shock of surprise that we discover this well-known custom, and all that it implies, already in existence during the last episode of the Great Ice Age."

The following instance is a curious example of the similarity of ideas amongst ancient and modern savages. In a tumulus in the Phœnix Park, Dublin, was found the skull of a dog, as well as the bones of a child. Now it is a fact that certain North American Indians are in the habit of burying a dog with the remains of a child for the touching

[1] "Ancient Hunters," London, Macmillan & Co., 1911, p. 146.

reason that the child might not be able to find its way to the realm of spirits, but that the dog, which can always find its way home, will lead it along the right path.

We are, it may again be claimed, entitled to argue from the modern savage and his customs and ideas to those of the ancient savage whom we only know by his remains; and when we compare what we know of the oldest and the latest we shall often be startled by the similarity of their methods and presumably of their ideas.

From what has gone before it will be understood that many of the most important facts that we have learnt concerning prehistoric man have been gathered from a study of his burying-places. With regard to these interments, and indeed with regard to the question of the exact position of prehistoric objects in the scale of what we shall speak of as Archæological Time, many difficulties arise which will have to be studied in the next chapter.

Meanwhile, it may be convenient to point out that so far as man's handicraft goes, so far back as we know anything about him, it is the handicraft of a true man made by a skilled man's hand. This may be proved for himself by any person who will take up two lumps of flint and try to make for himself a copy of the implements laid with the dead body of the man of the Chapelle aux Saints. He will retire from the task, probably with barked knuckles, and certainly with a greater respect than he has previously entertained for Prehistoric Man.

CHAPTER XIX

EARLY MAN—ARCHÆOLOGICAL TIME AND ITS DIVISIONS

AT this point it is absolutely necessary to devote some considerable amount of our space to the very important question of chronology, as to which the wildest and, in some cases at least, the most absurd statements are made day after day, and that not merely in the pages of the daily papers where we might expect them (though, of course, they flourish there) but even in manuals purporting to give the latest and most definite views of science. These wild statements very largely arise from a want of comprehension of what is meant by chronology, and that again arises from a want of clear thinking on the subject. For example, we often read some such statement as this—" Hundreds of thousands of years ago " [the brighter intellects do not hesitate to say " millions "] " man made these implements or carved these figures," or whatever may be the matter under consideration; and this with the same assurance and conviction as it might be stated that the Declaration of Independence was signed on the fourth of July, 1776. Those who have any knowledge of the subject know quite well that this sum of years, as applied to prehistoric man, is nothing more than a picturesque or rhetorical statement, just exactly on a par with the children's " once upon a time "; but the general reader cannot be expected to know this and is hopelessly misled. The object of this chapter is to put him right in this matter, so that he may in future be able to estimate at their correct value statements of the kind alluded to.

When we talk about " Time " we talk about an entity which may more or less arbitrarily be divided into days and

weeks and years, or again, and also arbitrarily, into epochs which may or may not be correlated with a known number of years in each case. For example, it is quite common to talk about the Victorian period and even to speak of things being "Early Victorian" or "Middle Victorian." To these, or at least to the first of them, it is perfectly possible to assign actual dates, since we know quite well that the late Queen Victoria came to the throne in 1837 and died in 1901. But there are many other cases, as will shortly appear, where no such correlation is possible, yet where such correlation is not merely attempted but actually stated as established fact. All this will be more readily understood when we come, as we shall shortly do, to concrete cases.

Let us begin by remembering that we have to do with three categories of what is called "Time." These are :—

HISTORICAL TIME (which is stated in actual years).
ARCHÆOLOGICAL TIME } Neither of which can be thus
GEOLOGICAL TIME } stated.

Let us consider each of these separately and then in relation to one another.

Historical Time deals with more or less well-established dates.

It informs us as to the year in which we and other important persons were born, when different battles were fought, when other great historical events took place ; it is in fact the skeleton and framework of history and comes into existence with it, very nebulous and uncertain at its commencement, more definite later on—in all important events during more recent periods practically unchallengeable. For example, no one will challenge the statement as to the date of the Declaration of Independence, nor will anyone hesitate to admit that the battle commonly known as that of Hastings was fought in 1066. In less critical days we used to see it laid down—on the dictum, by the way, of the Protestant Bishop Ussher—that the world was created in B.C. 4004, a statement to which few, if any, would now subscribe ; and this is an example of the impossibility of assigning exact dates to a time before history, which is the custodian of dates, had come into existence. The question

of Biblical chronology may be left for the moment while we turn to consider how far back we can go with any safety in connection with actual numerical chronology. Dealing with such records as we have, the discoveries made in Babylonia and in Egypt seem to afford us the greatest amount of information, and it is probably true to say that Egypt supplies us with surer and more definite information than any other yet attainable.[1]

Now in the history of Egypt we can tread with security as far back as the conquest of Alexander (B.C. 332). But that period, need it be said, is only as yesterday in the long history of this earth, or even of the history of the men who have lived upon it.

From Alexander backwards to the commencement of what is known as the First Dynasty, our path becomes less certain. There is indeed a kind of chronology, but how uncertain and indefinite that is may be gathered from the fact that the dates assigned for the commencement of the First Dynasty vary from 3315 B.C. to 5510 B.C., and that Professor Flinders Petrie, perhaps the greatest authority on Egyptology, who in 1894 fixed the date as 4777, has felt himself compelled by further evidence to change his opinion, and to assign 5510 B.C. as the proper date, the latter statement being made in 1906. It is right to say that the distinguished authority in question has on all occasions set forth his statements tentatively, with all reserve and for the use of scholars who are in a position to estimate the value and meaning of his findings, thus differing widely from the authors of the rash statements above referred to.

Yet even the more distant of the two periods just quoted, or any date resembling it, is only as the day before yesterday in the history of the globe or even of its human inhabitants.

So then we may safely say of Historical Time that of the events of to-day and yesterday we are tolerably sure, and as to those of the day before yesterday we can make reasonable guesses. Of those of the days before that we *know* nothing, though we can (and do) make many surmises as to them.

[1] From this point I think it permissible to quote, with slight alterations, from articles of my own on "The Earliest Men" which appeared in "The Catholic World," January and February, 1914.

Archæological Time may be defined, for the present purpose, as commencing with that uncertain epoch when man first made his appearance on this earth. It merges into Historical Time on the one hand—indeed all Archæology which is not Prehistoric belongs of course to History as well as to Archæology: and both kinds are, equally of course, co-existent with Geological Time.

In very large part and at its earliest periods almost entirely, as we shall see, Archæological Time depends for its estimate on Geological Time, since it is almost only by the stratigraphical character of early remains or objects that we can arrive at any conclusion as to their actual and their relative chronological positions. Thus whilst we are safe in assigning at present certain *Periods* to Archæological Time and are more or less safe in assigning certain objects to them, we are very far from being certain as to the dates which can be assigned to any of these periods—indeed, as will shortly appear, we can form no real conception of them in actual terms of years. Before dealing with this point it will be well to refer again to the matter of *Geological Time*, as to which most of that which has to be said has already been said in earlier chapters. It need only be repeated that, whilst we can obtain a very vivid idea of the immense ages which must have rolled by whilst the earth was becoming what she is to-day geologically, and may even form some kind of comparative scale of the lengths of time assignable to each period, it is wholly impossible to assign to any of them such definite dates as we can assign, for example, to the Stuart and Tudor periods in English History.

We may now turn our attention to the periods of Archæological Time and subsequently see how they fit in with geological facts. To begin with, mankind, as far as we know about him in all parts of the world, passed through an early period during which he was ignorant of the knowledge of metals and their importance and usefulness to his race. During this period such things as stones and sticks, fragments of bone and of horn, were the implements which he used or the materials out of which he fashioned these implements.

As stone of various kinds, but far most commonly and most importantly flint, was the chief material employed, these times have come to be known as the Stone Age, a term which does not exclude the use of other materials save those of a metallic character.

At first the implements constructed from stone were rough, rough that is by comparison with the more finished implements of a later date though nevertheless wonderful enough in their execution. To this period is given the name of the Old Stone or Palæolithic Period. It may have been preceded by an Eolithic Period and, at least in certain parts of the world, it faded into the next era through what is called the Mesolithic Period.

In that next era, though metal was still unknown and the materials remained the same, the process of manufacture had so much improved that the epoch is spoken of as the New Stone or Neolithic Age.

At the end of this man discovered the use of metals: but before we come to that important landmark in history it will be necessary to say something more about this Stone Age. As already mentioned, all the peoples of the world seem to have gone through a Stone Age, but it would be the greatest possible mistake to suppose that this age was synchronous in all parts of the world.

There was a time, no doubt, when the whole of what is now Europe was in the Stone Age: there was almost certainly a time when part of it was in the Stone and another part in the Metallic Age. There can be no manner of doubt that whilst Europe was enjoying the advantages, such as they are, of the Iron Age in which we now live, Australia, for example, was still in her Stone Period.

As to want of complete synchronism at the earlier prehistoric periods we have no very exact data, but facts seem quite undoubtedly to point in that direction. As to the later want of synchronism there can, of course, be no sort of doubt.

Another point to be borne in mind is this, that whilst man ceased, at the end of the Stone Age, to rely solely upon non-metallic substances as the raw material for his implements, he by no means ceased to use wood and stone,

bone and horn, in the manufacture of tools—in fact, as we very well know, he uses every one of them to this day in countless ways. He added something to his possibilities, just as when he substituted iron for bronze as the material of his weapons of war he added a further possibility. All this is so obvious that it hardly needs stating, but other very illuminating facts are by no means so obvious.

For example, there seems to be but little doubt that in England at any rate stone arrow-heads were used during a great part if not the entire of the succeeding period, which, as we shall shortly learn, is known as the Bronze Age. Nay, more, it is quite likely that the most skilfully fashioned of these objects belong to the Bronze Age and not to the Stone Period.

The reason of this is not far to seek, for we may quite well understand that bronze must have been a much more costly material to use than stone. Time was not as valuable as it is now, and anyway the experts of the period probably made even well-shaped arrow-heads much more rapidly than we imagine, so that it was much cheaper to use stone than metal in the case of implements which must have been constantly getting lost.

But even beyond this we know from history that many of the Saxon warriors fought at the Battle of Hastings with stone mauls—that is to say, with stone-headed clubs not very unlike those used at least in Neolithic times. It is probable that they were bored axe-heads, indeed it seems quite probable that the knowledge of how to bore stones may not have been acquired during what are properly called Stone Ages, and that all the numerous implements of that kind which have been found really belong to the Metallic times. At any rate the fact that we have to bear in mind is that there was here, as in the case of other periods, a considerable overlap of materials and that man did not wholly turn away from his old friends because he had discovered others in some ways more useful and even tractable.

At some period, unassignable to any particular date, man—almost certainly first of all in the Mediterranean basin, but perhaps more or less contemporaneously in different places—made the discovery that copper could be melted and run

into moulds. It is surmised that this was due to a fire having been lit on a rock containing a very large proportion of exposed copper ore. If this were the case, as it may well have been, there is no sort of reason, rather the reverse, why the discovery should not have been made in various parts of the world, even in various parts of Europe, at much the same time. At any rate a Copper period, or Æneolithic Age, seems to have existed in many places—in Cyprus, for example, which some have looked upon as the original centre of the knowledge of metals, and in Ireland, to mention but two places out of many. What seems certain about it is that its existence was brief.

At any rate the next period—one, it need hardly be said of enormous importance—was ushered in by a discovery on the part of some genius as unknown as the discoverer of fire, the discoverer of iron, and other benefactors of the human race. This discoverer, in some manner as to which we can form no idea, ascertained that an admixture of something like ten per cent of tin with the pure copper made a much more useful metal: and a knowledge of Bronze became the property of the world. Whether the knowledge of this combination of metals arose independently in different places, or was spread from a centre or centres to distant regions is doubtful, but there can be little doubt that in a comparatively short time the knowledge of how to make bronze had spread over the whole of Europe at any rate.

Then another discovery was made, which at least minimised the importance of bronze: this was the discovery of iron, perhaps made in a very similar manner to that of copper. The Early Iron Age, as it is called, is comparatively speaking, a thing of yesterday: indeed we are ourselves living, if not actually in the Iron Age at least in that Age of Steel which is nothing more than a development from it. In the passage from bronze to iron we can again see the overlap of materials which was alluded to above, for there are examples of implements—swords, for example—whose blades are of iron and whose handles are of bronze.

There was, as we have seen, in all parts of the world a stone age not necessarily—indeed in many of them certainly not actually—synchronous. Not all parts of the world

went through a Copper Age, nor did every part of the world go through a Bronze Age. The former fact is easily explicable by supposing that some tribe unacquainted with anything in the shape of metals had their ignorance dispelled by some visitor who was acquainted with the excellences of bronze and could show his hosts how to obtain the materials for making it and did not trouble to put them through a preliminary training in copper.

As a matter of fact, this is exactly what we know to have happened in connection with the Modern Stone Age peoples when they came in contact with men acquainted with metals. When Australia was discovered by white men they found the inhabitants still in the Stone Age. So far as they taught them anything except a love of strong drink and a wholesome fear of white men and their arms, they certainly did not trouble to put them through a Bronze Age. What these unfortunate savages learnt, or perhaps we had better say "picked up," from the whites was a knowledge of iron, so that they may be said to have passed directly from the non-metallic to the iron or even to the steel period.

Though the subject is replete with interest it is not necessary or even advisable to treat of the numerous implements which belong to the various periods which have thus been briefly reviewed; full information can be found concerning them in the text-books of Prehistoric Archæology. What it is important for us to understand is that in the general stream of human progress there were these various "reaches." As to certain difficulties in connection with the matter and more especially as to the question of the relation of "time" to these periods, more will be said in succeeding chapters.

CHAPTER XX

EARLY MAN—HIS IMPLEMENTS AND SOME CONSIDERATIONS THEREON

OF course, where we have them, the actual skeletal remains of man are of priceless value: yet, as will be seen shortly, it is often a matter of incredible difficulty to assign them definitely to their proper archæological horizon; thus the conclusions which can be founded upon them become a matter of uncertainty.

With this preliminary remark we may for a moment leave the question of the earliest skeletal remains which are open to observation at present. For it will be necessary first of all to review the various causes of uncertainty which have to be disposed of before any definite conclusion can be arrived at concerning a given group of objects—still more before any water-tight theory can be founded upon them.

In any given case a series of questions have to be put and answered, and these we may now consider in the order in which they usually arise.

1. Are the objects in question human or of human manufacture?

It might be thought that as regards skeletal remains at any rate this was not a difficult question to answer, nor is it in the vast majority of cases. In the example of the Chapelle-aux-Saints, for instance, where we have an entire skeleton which was definitely and purposely interred where it was found, in spite of its great antiquity no shadow of a doubt can be entertained as to its being the skeleton of a human being. But there are cases, and those just the cases in which one would like to feel quite certain about all the facts, in which matters are much more complicated than in this case.

Where, for example, a few perhaps considerably mutilated bones are found in a bed of gravel at some distance from one another, apart from the other questions which arise for consideration we have to decide (a) whether any or all of the bones are really human and (b) in the latter case whether they belong to the same individual. If the bones had not been interred but had actually been, let us say, washed down into their present situation, there is certainly nothing to negative the supposition that they belong to more than one individual and have been washed down together with the bones of an animal or animals.

Save under very exceptional circumstances it is impossible to be certain that the scattered bones with which we are dealing were all once the property of the same individual; indeed it is somewhat doubtful, in such cases, whether one can ever rise higher than a conclusion of probability on this point. In the great majority of cases we must admit that it is absolutely impossible to prove that all the bones belonged to the same body, even if no doubt is entertained as to their all being human. This, it may at once be admitted, is not a matter of overwhelming importance, for each bone can be considered on its own merits. But the question may assume a position of commanding interest if it be doubtful whether all the bones belonged to a human being. For example, in one of the cases which will be more fully dealt with on a later page, a very obviously human skull, of even modern type, was found in the same gravel with a lower jaw of rather monkey-like type. It was and is assumed still by many that these two objects belonged to each other because they were found at no great distance from one another in the same stratum. It is clear that this may be true, but on the other hand, it is equally clear that it may not be, in which case those who have spent much time in trying to explain the apparent anomaly which exists have been troubling themselves to no account. Let us put the matter in this way: if in the interment so often alluded to, if in any interment of any kind, the skull and the lower jaw in question had been found together, and in their natural relations, no one could then have doubted

that they belonged to one another. In that case a strong presumption would have been created that a second doubtful pair like those alluded to might also be parts of the same body. If, further, we were to find quite a series of similar pairs we should then entertain little or no doubt that our original find was also a pair. Again, if both skull and lower jaw were quite complete, so that they could be fitted together and it could be seen that the joint was perfect, one bone exactly fitting into another and each tooth meeting its antagonist of the other jaw with perfect regularity, then there could be no doubt left on the matter. As things are, with the imperfect fragments which are usually all that come to hand, and with the isolated character of the finds, judgement must clearly be suspended and no final and definite opinion can be entertained.

No more remarkable instance of how opinion may slowly ripen with regard to a given example can be imagined than that of the so-called Neanderthal skull. For years controversy raged round this fragment, which was regarded by different observers as human and not human ; as the skull of an idiot ; as belonging to one or other of widely different races. Yet it is now regarded as but one example of quite a number of others of the remains of a race of human beings of a very early period. The moral of all this is that the general reader should not be alarmed nor carried away by the extreme statements of scientific men on one side or the other, still less by the picturesque accounts which he finds in the columns of the press. It takes, in many cases, a very long time before scientific opinion can or does settle down to such a state of equilibrium as it now seems to have arrived at concerning the Neanderthal skull.

So much for some of the preliminary difficulties with regard to skeletal remains, but such remains are rare, whilst finds of implements are relatively common. We must now turn our attention to them in connection with our first question and endeavour to see how it is to be met. Most that need be said about it has already been said in Chap. XVIII, p. 192. We may at once dismiss all implements of what is called the Mousterian period and *a fortiori* all of a

later date as above suspicion : no one doubts that they are artefacts—that is to say, no one doubts that the great mass of them belong to that class, for of course there may be difficulties and doubts about a particular specimen. It is with regard to supposed earlier implements that the difficulty arises, and here something must be said concerning some of these objects. Before doing so it must be once more insisted upon that we should expect to find the earliest recognisable objects so like natural objects as to be almost indistinguishable from them.

Now in 1867 the Abbé Bourgeois discovered at Thenay, near Orleans, broken flints which he believed to be, and put forward as, implements of human manufacture. They were found in a geological stratum (Upper Oligocene) in which no human remains had then been found nor, it may be added, have since been found. This would not, of course, disprove their human origin and, in fact, a distinguished anthropologist, de Mortillet, was so sure of the human character of the implements that he invented a semi-human manufacturer for them by the name of *Homosimius Bourgeoisii*, a creature for whom there was not the slightest evidence, osteological or otherwise, save and except these disputed fragments of stone. Ten years later J. B. Rames found a number of flints at Puy Courny in Upper Miocene beds in Auvergne, which he claimed to be of human manufacture. De Mortillet was once more convinced and produced another hypothetical half-human manufacturer, named *Homosimius Ramesii*—this time, again without any kind of osteological or other evidence beyond the stones. In both cases scientific opinion has gradually settled down to the view that these flints, like those of Thenay, were shaped by natural agencies, such as water, earth-pressure, perhaps even lightning, and were not the work of man's hands. With this conclusion disappear also the two *Homosimii, Bourgeoisii* and *Ramesii*, whom we may, however, usefully bear in mind as examples of the saying that it is better not to prophesy until you know.

We may pass over some other less important cases and come to the Eolith controversy, which cannot yet be said to be at an end.

These eoliths, which have attracted much attention both in England and on the Continent of Europe, are found, in some cases at least, in gravels of great antiquity not belonging to the modern river systems. If, therefore, these things really are human implements, they must belong to much more distant ages than any other implements known to us. It is, of course, merely a question of fact as to their character. Up to a comparatively recent period, there was undoubtedly a fairly strong body of opinion which was favourable to their being artefacts, but it must be admitted that recent observations have rendered that position much more precarious. That such implements, or rather stones shaped like them, can be produced by cart wheels from flints lately laid upon the road for its repair does not seem to prove that all eoliths are natural productions, since, after all, the cart wheel is not a force of nature but a kind of human tool even if unintentionally employed. Very much the same may be said as to the discovery that stones identical with the so-called eoliths could be made, and actually were made, by the evolutions of a kind of iron rake, in a mixture of water, chalk, flints, and clay in the process of making cement at Mantes. No doubt both of these observations weakened the case for the eoliths, but cannot exactly be said to have destroyed it. A crushing piece of evidence brought forward by the learned archæologist, the Abbé Breuil, has, however, convinced many, it might even be said the vast majority of, prehistoric archæologists, that it is unsafe to look upon eoliths as being artefacts.

The observer last mentioned has found in Lower Eocene sands in Clermont undoubted eoliths with the detached flakes still in situ. No one has ever suggested that man existed at this period, and even if he had, that fact would not alter the importance of the Abbé's demonstration that these so-called implements can be made by a process of nature, and that a process which must have been in operation for long ages, down to the present day—namely, the slow gradual creeping movements of strata whilst settling down under the pressure of the soil. This pressure causes the flints to be squeezed against one another, and flakes to be removed. By this process is produced that characteristic

"eolith" form which resembles a slice of bread and butter with a piece bitten out of it.

It has already been pointed out that we cannot definitely accept any so-called implement as an artefact until we are assured that it could not possibly have been shaped by nature's agencies. It has now been shown that eoliths can be shaped by a definite and perfectly recognisable natural agency and it cannot, therefore, be assumed that any of them have ever been manufactured in any other way.

We may pass from eoliths to the Icenian or Rostro-carinate implements found by Mr. Moir below the base of the Red Crag of Suffolk and described with great care and minuteness by Sir Ray Lankester.[1] The geological period to which the Red Crag belongs is not quite clear, for, though it has usually been assigned to the Pliocene series, Sir Ray thinks that this is an error and that its fauna affords a definite proof that it should be included in the Pleistocene Age. There is still some doubt, expressed by Professor Sollas, as to whether these objects are artefacts or not. If they are, they unquestionably set back the date of man's appearance on the earth to an even more distant period than has heretofore seemed to be provable. As in the case of the Abbeville implements, and perhaps we may even say of the eoliths, time will tell; and until further facts have been accumulated one must suspend one's judgement on this matter.

As to all later implements at present before the scientific world, it may be said that their human origin is undisputed and that their workmanship is such as to prove that it was a man in every sense of the word who made them. No one suggests a *Homosimius* as their maker.

Further, it may be added that they fall into series which cannot here be described—series which belong to sub-periods, and are so capable of recognition that when found in connection with an interment, for example, it is tolerably safe to place that interment in a definite period by reason of the evidence afforded by the implements with which it has

[1] Breuil's paper appeared in "L'Anthropologie," 1910, Vol. XXI, p. 385, and Lankester's in the "Philosophical Transactions," Vol. 202 B, p. 283.

been interred. It will readily be understood how valuable this is to students of prehistoric subjects.

2. If it is agreed that the objects are human or of human manufacture, what is their stratigraphical position ?

It is obvious that the reply to this question can only be arrived at on geological lines where the objects in question have been discovered at any depth below the surface. A large number of prehistoric objects—neolithic flints, for example—are commonly found either on the surface of the ground or in the surface soil turned up by farming operations, or even by the digging of moles or rabbits. Concerning these there is no question. Palæolithic implements not found in caves have very commonly been discovered in river gravels, the so-called " drift " implements. This merely means that they have been washed down, with gravel of natural origin, by the river on whose banks they have been discovered—a fact further made obvious by the worn appearance of the angles of the implements. A more interesting discovery is that of implements at the place of their manufacture, and this is especially the case when those implements are of the Palæolithic Period.

Those who desire to read a most interesting account of the discovery of such a palæolithic workshop can do so in " Man the Primaeval Savage,"[1] where they will also be able to admire the painstaking way in which the whole facts of the case were worked out by the discoverer. Put briefly, what happened was something like this. The manufacturers of the tools worked on the muddy flats beside a pool of water. Leaving, as we may suppose, one evening their implements made and half-made, together with the chips and blocks which were their refuse and their raw material, they returned to find them no more, for prolonged rain and floods had covered them with a thick coating of mud before the workmen were able once more to resume their labours. Ages afterwards, when the mud of this early day had proved itself of value for the making of bricks, the floor of the ancient workshop became exposed and its nature revealed by the objects which lay upon it. These facts, however interesting and illuminating they may be,

[1] By Worthington G. Smith, London, Stanford, 1894.

are not of great importance from our point of view, which is especially concerned with the question of the antiquity of man. Where the question of the geological period of skeletal remains is concerned other points have to be borne in mind which must be settled before the matter of stratigraphical position becomes of any special importance.

3. Are the skeletal (and perhaps also other) remains in their natural position, or is their disposition artificial ?

Here we approach a most difficult matter, yet it is one which must at least be grasped in outline if readers are to be able to form an intelligent opinion on the kind of facts constantly laid before them in the pages of newspapers. Let us take one or two examples. In the first place, we may picture the lonely death of a man, ages and ages ago. He is drowned, let us suppose in some lake or pool ; his body is held down by weeds ; his bones are covered with a thick layer of mud. Slowly the lake silts up ; there is an elevation of the ground and the whole area becomes part of what we call the ordinary dry land. Then it turns out that a use may be made of this ancient dried-up mud and it is excavated until one fine morning the bones of the ancient inhabitant are found. The papers get hold of it and we have captions as to the discovery of an antediluvian and the like. Now let us suppose, on the other hand, that, instead of the events just described, the bones had come to rest where they did because a murderer some century ago had dug a deep hole and therein concealed the body of his victim. The position of the bones in either case might be identical, yet the difference in age between them might be measurable only in thousands of years. If one thinks over the matter one can imagine quite a number of ways in which a body might have been buried deep down in the soil, yet quite recently. A landslip might cover a sleeping tramp with tons of earth and no one be the wiser. In fact, error may creep in by various paths.

How then are we to find our way out of the difficulty ? The first thing to consider is whether the soil in which the bones have been found is natural untouched earth or not, and this point can be settled by a person conversant with excavations if he gets a proper chance. Unfortunately this is generally just what he does not do, for

naturally enough, in the enormous majority of cases, the discovery is accidentally made by a workman who is neither acquainted with nor interested in the difficulties we have been considering, and by the time the expert is on the spot all the conditions for forming an opinion may have been destroyed. The first thing, then, which one has to ask oneself when bones have been found under conditions which may suggest great antiquity for them is this: were they buried there or not? But there is another point which will also claim our attention. In a number of these cases other objects are found with the bones which we are trying to date. These objects may be implements made by human hands or they may be the bones or teeth, or both, of animals belonging to races extinct or still in existence. In any of these cases the objects thus found may afford invaluable evidence as to the date of the body. But the evidence which they afford may be wholly fallacious, so that the next question we have to ask is this:

4. Is the collocation of objects significant or not?

Here again a few instances will show the kind of considerations which arise. Let us suppose, as may quite well happen, that the skull of a man is found in a mass of river gravel, together with the teeth of a hippopotamus and some fragments of Roman pottery; does this prove that they were all of the same period?

Unquestionably it does not, for the hippopotamus and the pot in any case cannot have been contemporary. Nor need any of them be, for all may have been washed down to the same spot, at the same time, by the same flood, but from quite different places. We can, therefore, attach no significance to this collocation; it teaches us nothing.

Let us now suppose that we find in an interment, besides human bones, some flint implements and a bronze pin, what may we conclude? Supposing that it is clear that none of these things are of later introduction, it at least proves that the bones belong to an individual of the Metallic Period. Or again, suppose we find in the case of an interment that the tooth of an elephant has been placed by the remains of the dead, we are not, therefore, entitled to claim that the mammoth and the man in question were con-

temporaries. The tooth may have been a cherished possession of a man who had never seen or heard of a mammoth. It may have been a kind of fetish, what we should now call a "mascot." It may have been buried with him for any one of these reasons or for some other. Finally, however, when we find an obvious interment—let us say in a cave like that of Chapelle-aux-Saints—where the bones are in an undisturbed position, where they are surrounded by or resting on flint implements, then at least we may say that there is the strongest possible reason for believing that the remains and the implements are exactly contemporary. And further, if, as would usually be the case, we can say to what archæological period the implements belong, then we are fairly entitled to say that the bones are those of a man of that period and that their critical study should enable us to form a fair idea of the physical characters of the human beings of that date.

Those who read what has gone before and who are not in the habit of troubling themselves much about the kind of things here dealt with, will be apt to think that the whole matter is not only very dull but that it bristles with captious questions, and in any case is a fine example of "much ado about nothing." Well, that is not so. The most acute controversy of to-day, perhaps, is that which rages round the question of the age of man upon the earth.

This controversy is concerned with the question of the remains, physical and otherwise, of the early inhabitants of the earth—in fact with the subjects dealt with in this and the preceding chapters. One of the chief aims of these has been to show in the first place how many matters have to be taken into consideration before even a tentative theory can be advanced. In the next place, it has been necessary to point out how many pitfalls surround the observer and how easily he may make the worst and most fundamental mistakes. All these things suggest great caution and reserve, not only in formulating but in accepting a theory.

In fact it is most unsafe to base any but the most tentative theory upon any isolated specimen; the story of the Neanderthal skull proves that. Even where the evidence

is more satisfactory, the conclusion arrived at can rarely, if ever, rise to a position of more than very great probability, though from time to time it reaches one of as absolute certainty as is obtainable with regard to earthly matters. Thus it is as certain as anything can be that man has inhabited this earth for an immense period of time, though it is quite uncertain what actual or approximate number of years should or can be assigned to that period.

The evidence for the existence of the so-called Neanderthal race with certain marked physical characteristics, is unquestionably convincing, yet it would be rash to assign to this race every skull which presents the characters in question. Modern individuals and races have been known to possess them and, therefore, unless there is some other collateral evidence, no such conclusion can be arrived at with conviction.

Having thus sketched the foundation ideas of the subject of prehistoric archæology we may now turn our attention to the actual discoveries of human remains which closely touch the question in which we are interested—namely, the date of man upon the earth—before discussing what the Church and Science have to say upon that subject.

CHAPTER XXI

EARLY MAN—ACCOUNT OF DISCOVERIES OF EARLY SKELETONS

IN the present chapter it will first of all be our task to deal with the earliest, or what are thought to be the earliest, remains of human beings. This will have to be a mere sketch, but it will, it is hoped, be sufficient to make the problems under consideration clear to those who may not previously have come in contact with them.

The TRINIL REMAINS were discovered in Java by Dubois in 1891.[1] These remains consist of the top part of a skull, two molar or "back" teeth, and a thigh bone. These objects were found, it is true, in the same locality, but as much as forty-six feet apart from one another. It is thus clear that they did not form an interment, and it is of course not possible to prove that they all belonged to the same individual. It is assumed that they do, but that view must always remain an assumption, since an expedition fitted out and financed by Madame Selenka, the widow of a well-known scientific man, completed and reported upon its operations. After vast expenditure of labour and the excavation of a large tract of land the investigators discovered one more tooth. They erected a monument to the possessor (or possessors) of the bones and returned to Europe. No account of the tooth in question has been made public, so far as the present writer is aware, but it is understood that it is in every respect human in its characteristics. It cannot be proved, perhaps it can hardly be claimed, that it belongs to the same individual as the other bones, assuming that these all belonged to one person. It may be the tooth of

[1] The subjoined account is taken and in large part verbatim from my paper already referred to.

some quite modern person which has found its way to a comparatively deep position by falling down an earth-crack or by some such method. The first-discovered remains have been assumed to belong to a single individual who has been, perhaps a little prematurely, named *Pithecanthropus erectus*.

Be that as it may, and apart from the initial difficulty as to whether all the objects belong to the same skeleton, there is a further difficulty as to the characters of the skull, reminding one of the earlier differences of opinion as to the Neanderthal skull, of which some account will shortly be submitted. Dr. Munro, a learned writer on subjects of this nature,[1] gives a list of seven authorities who look upon the fragment of skull as having belonged to a human being, of six other authorities who are clear that it was once possessed by an ape, and of still another group, also seven in number, who prefer the middle course of believing that its owner was some sort of creature intermediate between men and apes. What is clear is that whilst there is this discordance of opinion amongst authorities—and it may at once be stated that each of these twenty persons has every claim to that title—the plain man may well suspend his own judgement and conclude that, until a fundamental question of this kind is settled with at least some approach to finality and general consent, it is not much use to begin building theories, seeing how insecure is their foundation.

Another curious fact connected with these differences of opinion has been quoted by Dr. Munro from the pages of de Mortillet, a veteran man of science whose name has already found a place in these pages. He writes: "Les avis ont été on ne peut plus partagés. Ils se sont tout d'abord parqués par nationalités. Les Anglais, bien que compatriotes de Darwin, ont fait des grands efforts pour démontrer qu'il ne s'agit que d'un homme, un homme très inférieur, mais déjà un véritable homme. Les Allemands, au contraire, se sont froidement ingéniés à prouver qu'il ne s'agit que d'un singe; Les Français ont purement et simplement adopté les déterminations du jeune savant hollandais. C'était chose facile pour des compatriotes de Lamarck."

[1] "Palæolithic Man," Edinburgh, Oliver and Boyd, 1912.

Apart from these fundamental difficulties it is by no means certain as to what was the exact geological horizon to which the remains belonged. Some believe that the deposit was of Pleistocene, some of Pliocene age, the former opinion now being, I understand, in the ascendant. It is a comparatively small point when compared with that just alluded to, but it adds to the general uncertainty and to the impossibility of making any very great use of these remains in respect to theories concerning early man.

It must always be remembered, however, that the state of uncertainty which at present unquestionably exists may, as was the case with the Neanderthal skull, come to an end and the matter be cleared up by further discoveries. But it seems impossible, however, after Madame Selenka's labours, to imagine that such discoveries can take place in the same neighbourhood as that where the original discovery was made.

A parenthetic discussion of a matter which always crops up in connection with these early skulls may here be undertaken.

In any description which we read of them we shall undoubtedly come across the statement that "the cranial capacity is estimated as being . . . which is about the same as that of the . . . race." It will be convenient here to explain and criticise this statement for the sake of those who are unfamiliar with the methods of ethnology. Roughly speaking, the size of the interior of the skull corresponds to the size of the brain which it once contained, and, also very roughly speaking, the size of the brain is generally considered as having some relation to the intellectual position of the former owner of the skull. The cranial capacity is measured by filling the interior of the skull with shot or some such thing and pouring it out into a measure. Anyone who has ever seen a skull can understand that with ordinary care and precautions all this is an easy enough procedure. But where, as in most cases of early skulls—in that of the Trinil skull, for example—we only have a fragment of the original, the matter becomes one of great difficulty. It is not exactly a matter of guesswork, but the extraordinarily different conclusions arrived at by different observers, all trained and experienced

anatomists, at least show the great difficulty and uncertainty which surrounds the process.

In the case of the Neanderthal skull so often quoted, the earlier measurements were vitiated and the skull made to be of much smaller capacity than it really was by the fact that a certain small point in connection with cranial anatomy was not then fully understood. It is not easy to estimate the cubic contents of a fragmentary skull; but suppose them estimated, how far will that help us? It must be conceded that size of brain is not always a safe index of intellectual capacity. Tiny dwarfs with brains no bigger than those of a baby have been possessed of intellects surpassing those exhibited by many a grown man or woman who has yet passed a lifetime outside a home for the feeble-minded. There was a well-known dwarf who died in America aged about twenty years and measuring about the same number of inches. She was of Dutch origin and went by the name of the Princess Paulina. Her brain was, of course, in size that of a child of her own stature—that is, immeasurably inferior in size to that of the brain of the lowest race of savage ever seen. Her body-weight was only one hundred and forty-four ounces, whilst the weight of the brain alone in an ordinary woman averages about forty-five ounces. If brain be everything she ought to have had something less than the intelligence of an ape. Yet the doctor who attended her in her fatal illness relates that she was "of a good general education, and speaking four languages—her native Dutch, French, German, and a little English." It does not do to stretch the long arm of coincidence too far, but it is not always the case that a skull of small size was therefore in possession of a person of inferior or imperfect intellect. Take, for example, the case of Gambetta, first Prime Minister of France after the war of 1870–1, who, whatever may be said about him or against him, could certainly never be stigmatised as brainless. Yet Gambetta's brain-weight, as ascertained by a post-mortem examination, was only two and a half pounds, whilst the average British brain weighs about three pounds. In fact, Gambetta's brain was considerably inferior in point of weight to the average brain of savage tribes. Had his skull been discovered and esti-

mated on the cubic capacity lines by some savant in the future, wholly ignorant of who had been its possessor, it would almost certainly have been declared to have belonged to a member of some very inferior race of human beings. Nevertheless it is fair to say that, with all the difficulties and doubts which must necessarily attach to it, skull capacity is the best and indeed almost the only measure which we can have of the intellectual possibilities of an otherwise unknown race. The fact is that, from the material point of view, it is possibly the amount of grey cortex or the association of fibres, or something of that sort which we cannot estimate by measurements, which makes the difference between brains. As we can in many cases estimate the cubic capacity with accuracy, as it is the only indication or almost the only indication which we have of the intellectual position of an extinct race, and as it has a certain correspondence with facts, we can use it and can attach considerable importance to its teachings. But we must always bear in mind the fact that the method is not infallible in its application.

After these observations the reader will be in a better position to estimate the opinions now to be laid before him.

The Trinil skull is in a most imperfect state and it is, therefore, a matter of the greatest difficulty to estimate its cubic capacity. Its original discoverer puts it down as 855 cubic centimetres,[1] but Keith thinks that this is an underestimate, though he does not commit himself to any definite statement as to the capacity.

The Piltdown Skull, which has lately attracted so much attention and has been the cause of much controversy, was found by Mr. Dawson in a flint-bearing gravel overlying the Wealden (Hastings beds) at Piltdown in Sussex, and was described by him and by Dr. Smith Woodward.[2] The objects found in this gravel bed consisted of a fragmentary skull, a lower jaw, and some flint implements claimed to be

[1] It may assist readers to have the following facts before them.
Average capacity European skull 1550 c.c.
" " Australian native 1250 c.c.
" " Mousterian (prehistoric) 1620 c.c.

[2] In the "Quarterly Journal of the London Geographical Society," March, 1913.

of Chellean, that is, of early Palæolithic period. Its describers claim that all the objects belong to one another and that they "cannot safely be described as being of earlier date than the first half of the Pleistocene epoch." The first piece of uncertainty about these objects is their connection with one another. A difficulty, as will shortly be seen, arises in connection with the jaw, which does not seem to harmonise in its characters with the skull itself. Some, therefore, think that the two bones did not belong to the same individual. Leaving this point aside for a moment until we deal with the Heidelberg jaw, let us pass to the next point of difficulty. It has already been said that the skull when found was in a very imperfect condition. Before any attempt could be made to arrive at an opinion as to what it looked like when complete, it was necessary to essay what is called "reconstruction"—that is to say, to make a model of the whole skull, working from the proportions of the part which is in existence. Now without going into details, it may at once be said that no more difficult task can well be attempted, and this indeed is obvious from the widely divergent results obtained by undoubted authorities—results which make it quite impossible for anyone to found, at least at present, any reliable theory in the construction of which this fragment of bone forms a factor.

The first describers of the skull, as a result of their reconstruction, claim that the cubic capacity is 1070 cubic centimetres, that is, somewhat less than the cubic capacity of the average Australian native. But, on the other hand, Professor Keith,[1] an undoubted authority on craniometry, has also made a reconstruction which differs most widely from the earlier description, for he says that the creature thus reconstructed was one which "could neither breathe nor eat, which was an utterly impossible condition." Further, he adds that "the mistake had been made similar to that in 1887, of putting a chim-

[1] Since this was written Professor Keith has produced a book, "The Antiquity of Man" (London, Williams and Norgate, 1915), which is largely given up to a consideration of this skull. It is eminently improbable that this work will end the controversy or that the Professor's conclusions will be allowed to go unchallenged. The matter must be considered, therefore, as remaining in a highly unsettled condition.

panzee face on a human skull." According to his view the cubic capacity works out at 1560 cubic centimetres, in other words, the skull is one of very considerable size, quite on the large side amongst skulls. Where authorities of this eminence differ and differ so much it is not for outsiders to express opinions. This much, however, may be said, that whichever is right, the skull is clearly the skull of a human being and presents no characteristics which would prevent it from being looked upon as the skull of a man of to-day. The same cannot be said concerning the lower jaw found in the same gravel, which must now be considered in connection with the

HEIDELBERG JAW, found near the place after which it was named and first described in 1908. This jaw was found by itself and without any skull. It is assumed to be human, as the Piltdown jaw is also assumed by most to be human, but there is at least the possibility that neither of them may have been such.

The Piltdown jaw was at first stated to have belonged to a creature which could not talk, but it is now admitted that the anatomical character on which this view was founded does not warrant the conclusion based upon it. There is no doubt that both of these jaws, and more especially that from Piltdown, do present highly simian or monkey-like characteristics and thus depart from the pattern which obtains amongst mankind to-day. But there is a most curious feature about the Heidelberg example: this is that, in spite of the simian character of the jaw-bone, the teeth which it contains are more like the teeth of the highest races of to-day, and less like the teeth of monkeys than are the teeth of some of the lower races of the present time. To put it briefly; the jaw is more monkey-like and the teeth are less monkey-like than the jaws and teeth of people of to-day; and it may at once be said that this combination of characteristics is one of the most puzzling things to an anatomist. The teeth in the case of the Piltdown example are also stated to be definitely human.

The NEANDERTHAL REMAINS are of the greatest interest from several points of view. First of all they have been for a lengthy period before the scientific world and have been

criticized and recriticized, described and redescribed, until at last opinion has somewhat settled down about them. They were found in 1857 in a cave in the gorge from which they are named, which is situated near Düsseldorf. They were described in the next year by Schaafhausen and were claimed by Huxley to be the bones of a perfectly new and very ancient type of man. Virchow, an authority of at least equal rank, said that they were the bones of a quite modern man who had suffered from a peculiar disease. It is almost the case of the Piltdown skull over again. In 1901 Schwalbe carefully examined the bones and the various views which had been expressed concerning them. He was able then to tabulate four distinct and different opinions with regard to the skull, under each of which were several sub-opinions.[1] Nothing certainly could appear more uncertain than the character of the skull. Schwalbe himself described the individual as *Homo primigenius*, to distinguish him from *Homo sapiens*, the man of to-day: yet we now know that the Neanderthal bones belong to what is a well-recognised race. This is the second point of interest alluded to above; for the Trinil, Piltdown, and Heidelberg specimens are so far of a purely isolated character, and being such cannot give us any certain aid in forming conclusions of a general character.

Such is not the case with the now fairly numerous examples of Neanderthaloid type, as to which Keith does not hesitate to state that in his opinion "the Neanderthal type represents the stock from which all modern races have arisen."[2] It is also recognised that his cranial capacity, thought by Huxley and others of that period to have been very low, was, on the contrary, quite respectably high in the catalogue of capacities.

This change of opinion arose from a trifling though important discovery to which allusion has previously been made and which may be more fully explained at this point.

[1] For an account of this matter see a work by the author, "A Century of Scientific Thought," published by Burns & Oates, London, 1915.

[2] "Ancient Types of Man," Harpers, 1911. In this little book and in Duckworth's "Prehistoric Man," Cambridge University Press, 1912, will be found succinct accounts of all the finds of prehistoric bones made up to the date of their publication.

If the reader will pass his hand over the back of his head at the point where the neck-muscles are attached to the skull, he will feel a more or less prominent knob of bone, known to anatomists as the inion. In modern races this corresponds with the line of division between cerebellum and cerebrum—the great brain and the lesser brain, to use the more popular terms. In Neanderthal man it is now known that this was not the case, but that the knob in question is from twenty to twenty-five millimetres above the upper limit of the cerebellum. The failure to recognise this fact had thrown out all the measurements of the earlier observers, and this shows how cautious one must be in accepting conclusions and how very easily the most distinguished observers can go wrong even over a vital matter of this kind. "The size of the cranial cavity in the Neanderthal type was much under-estimated. In place of being 1230 c.c., as Huxley supposed, it is over 1500 c.c., as Manouvrier and Boule have estimated. It is a striking fact that the brain had reached, as regards size, more than a modern degree of development in the Neanderthal type; indeed, 1480 c.c., is usually accepted as an average for modern man."[1]

From this point onwards we have fairly complete series of human skulls. We are no longer obliged to rely on the imperfect and uncertain evidence of fragments and single examples, but have groups of skulls which we can compare and correlate with one another. Thus though there are, and there must probably always be, a great many difficulties to be cleared up concerning the now fairly numerous remains of prehistoric man which have come to light, we know enough to draw some important and tolerably certain generalisations. We can more than tentatively divide them into races, such as those of Neanderthal, Cro-Magnon, and others. We can place them in periods such as Mousterians, Aurignacians, Magdalenians. All this we can do with tolerable certainty. Further, we can quite definitely say about all these races that those who belonged to them were in every sense of the word—Men. They had the skulls of men, and what is more, they had the hands of men, the skilful hands

[1] Keith, *op. cit.*, p. 105.

of the mechanic—man the tool-maker, not a whit less skilful than the tool-makers of to-day. At a later date than the Mousterian, but still during the Palæolithic period, man revealed the fact that he had an intensely artistic nature coupled with great artistic powers. This we learn from those of his drawings and carvings, and they are surprisingly numerous, which have come down to us. Finally, we know, as has already been said, that he had one religious belief which exists to-day, the belief in another life. The earliest known interment, that at the Chapelle-aux-Saints, of Mousterian—that is of very early Palæolithic—age, exemplifies all these facts. The bones are those of a young man—a man, not an intermediate creature. The tools with him have been skilfully made, and the fact that they are there shows the belief in another world held by those who survived him and laid him in his grave.

CHAPTER XXII

EARLY MAN—CLASSIFICATION—PREHISTORIC PERIODS

IN the present chapter it will be well to assemble the facts which have just been under consideration into some form of classification, after which it will be possible, in the succeeding chapter, to attempt an account of the Glacial Period and the relation of the races to be described in this chapter to it. In these chapters there must needs be a certain amount of overlapping and repetition which may be excused on the ground that its object is to bring the points in question more clearly and forcibly before the minds of readers. All these accounts lead up to the really important point, namely, the Age of the Earth, and far more important, the period during which it has been occupied by Man. These considerations will form the subject matter of a further chapter.

Let us now set down the periods of prehistoric time with their leading features.

A. THE STONE AGE OR NON-METALLIC PERIOD, during which stone, wood, bone, horn, were the raw materials from which implements were made.

a. **The Pre-Palæolithic Period,** assumed but at present unproved. Eoliths and the like, if really artefacts, would belong to this time. It may be looked upon as being the period prior to that in which undoubted stone implements were constructed, the period in which the unworked or scarcely worked stone was used for the purpose for which more highly finished tools were afterwards constructed.

b. **The Palæolithic Period.**

c. **The Mesolithic Period,** or period of transition from the older to the newer Stone Age.

d. **The Neolithic Period.**

B. THE ÆNEOLITHIC PERIOD, during which copper came into use; the period of transition between the Stone and the Metallic periods.

C. THE METALLIC PERIOD.

a. **The Bronze Period**: *b.* **The Iron Period.**

These periods are full of interest to the archæologist: with the majority of them we, however, have here no special concern.[1] Our interest is in the earliest men, their advent on the earth, their physical and mental characteristics, their supposed relationship to lower mammals and matters of that kind; and for this reason we may confine our attention to the people of the Palæolithic Age and mainly to those at the very beginning of that period.

Let us see how they have been classified. The classical names are those devised by Mortillet and adapted from the names of places in France where remains of the races in question[2] have been first or chiefly found, or with which they are in some way or other very definitely associated. Mortillet's classification is as follows:—

Chellean, from Chelles, a place a few miles east of Paris.

Mousterian, from the cave of Le Moustier on the river Vezère in Dordogne.

Solutrean, from the cave of Solutré near Macon.

Magdalenian, from the rock-shelter[3] of La Madelaine in Dordogne.

[1] Those desirous of reading a brief account of these periods as they were in England may be referred to a work by the present writer entitled "Remains of the Prehistoric Age in England," published by Messrs. Methuen.

[2] It may be well once more to insist that the term "race," as used here, does not necessarily mean that the persons belonging to it were as distinct from another so-called "race" as—say—a Swede is from a Chinese. It may be that this actually was the case or it may be that there was no more difference between them than exists between the varieties of Englishmen who might be described as Georgians or Victorians. The eighteenth and the twentieth century Englishmen differ from one another anatomically in no kind of way, though culturally they do. In the case of some of the prehistoric "races" there are very distinct anatomical differences such, for example, as exist to-day between Australian and European skulls. The use of the words "zone of civilisation" might make matters clearer and these have been employed sometimes in these pages. But after what has been said in this note the meaning of the term "race" will no longer be ambiguous.

[3] A rock-shelter is a place of habitation under an overhanging rock: a kind of cave without side-walls. It was a favourite place of habitation, at any rate during the later palæolithic times.

Whilst in its main outlines this classification remains accurate, and most probably always will do so, it is necessary, in view of numerous discoveries which have of late come to light, that it should be extended and sub-divided. The following classification of the Palæolithic Period, taken very largely but not entirely from Sollas, will serve to show the present state of opinion and will be followed in the next chapter.

LOWER OR OLDER PALÆOLITHIC:—

Mesvinian, Strepyan: these are accepted as definite periods by Sollas but are included in the next by most authorities.

Chellean: this and the next make up what Mortillet named the Chellean. There is no doubt that the implements assigned to this period were artefacts, and those found with the Piltdown skull are claimed to belong to this zone.

Acheulian.

MIDDLE PALÆOLITHIC:—

Mousterian: Implements and bodily remains well known. Interment at Chapelle-aux-Saints.

UPPER OR YOUNGER PALÆOLITHIC:—

Aurignacian, Solutrean, Magdalenian: All well known both as regards implements and bodily remains.

The characteristic CHELLEAN implement, usually called a *coup-de-poing*,[1] may be looked upon as a kind of rude stone hand-axe. By this is meant an axe-head never intended to be affixed to a haft in any way, but to be held with its more or less rounded butt in the palm of the hand. It might be thought that this would be but an ineffective weapon, but let any person of that opinion take one in his hand and remember that he is going to use it in a conflict with an adversary armed in the same manner and half naked like himself: he will feel that for a hand-to-hand conflict he might be much worse armed. Against wild

[1] Sollas's term of *boucher*—from Boucher des Perthes, the first to make these implements generally recognised—has not received general recognition.

animals, and especially against the huge beasts with whom the man of the period had to contend, it is less easy to see how he was able to defend himself; but that he did so, and successfully, is sufficiently obvious. Moreover, that very fact is decisive as to his intellectual faculties, for it can only have been by superior cunning and thought that he was able to get the best of it in a conflict with animals capable of destroying—had physical force alone entered into the case—whole hecatombs of such defenceless creatures as these early men must have been. If the Heidelberg mandible and the Piltdown remains belong to this period, as we may at least tentatively suppose, we can say something about the man of this early period in addition to what has been stated in a previous chapter. Keith, who assumes the evolution of man from some simian form, says of the Piltdown remains and of the Heidelberg mandible: "The jaws of these early human beings were primitive enough, but certainly not simian. At even this early stage the simian condition was long past." Certainly, if Keith is right, as now seems to be clear, and the Piltdown cranial capacity was 1500 c.c., there is no doubt that his skull was as roomy as that of the most intellectual races of to-day, nor is there any reason to suppose that his intellectual potentialities were inferior to theirs.

At any rate man comes before us first of all as man anatomically and as nothing else.

The ACHEULIAN civilisation is a sub-division of that called Chellean by Mortillet. It is distinguished from the former by the lighter and smaller implements which characterise it. We have no knowledge of any skeletal remains which might be associated with this period.

The MOUSTERIAN civilisation corresponds with the Middle Palæolithic era and is, for the moment, perhaps the most interesting for us. A great deal concerning the earlier races is, and perhaps must always remain, surmise, but of the Mousterian man we know now a great deal. What is more, we can now with reason say that we know of him as a race; that is, we have a sufficient number of relics of this period to construct a picture of a group of men, not merely of an isolated example. Mousterian man had given up or

nearly given up—some would say entirely given up—the use of the *coup-de-poing*, hitherto the characteristic stone implement, and in its place used broad and thick flakes worked on one side, together with scrapers[1] and points, i.e. sharpened fragments of flint for use in the hand. Of skeletal remains of this race we have a large number, including the Neanderthal skull, once a storm-centre of debate. These remains prove the race to have possessed roomy skulls; they were a large-brained people and hence, it may be argued, a people with at least as considerable potentialities of intellectual advance as we possess to-day. They were a people with the capable hands of artificers, as is proved by the beautiful implements which those skilful hands turned out. They were a people with a reverent feeling for their dead and a belief in the survival of the individual in another world, as is proved by what we have learnt from their interments. In a word, physically, intellectually, and psychologically they were men and women indistinguishable from those now inhabiting the earth.

The YOUNGER PALÆOLITHIC includes four zones, or three zones and one of transition. Nothing need be said about the skeletal characters of the men of any of these, for there is nothing to distinguish them from those of modern races; but a few words may be bestowed upon some of their other characteristics and particularly on the art which forms so very distinctive a feature of this time.

This is very markedly the case in the AURIGNACIAN epoch, for the people of that time, as has recently been shown, displayed a most astonishing love for and skill in art, as illustrated by the perfectly wonderful series of cave paintings which have been discovered in various parts of Europe—notably, for example, at the caves of Altamira and Pair-

[1] "Scrapers"—implements for cleaning away fat and other fleshy remains from the inside of skins in order to render them suitable for wearing purposes—are amongst the commonest objects in the list of stone implements. They are of several kinds: those named in the text have the scraping edge at the side of a long fragment of flint, not at the end of a long or short piece as is the case with the common scrapers of the later palæolithic and of the neolithic ages.

non-Pair, in Spain and France respectively. In these and other caves bisons are represented as single individuals and in herds, as well as many other animals then co-existing with Aurignacian man.

One of the most extraordinary and incomprehensible features of these pictures is that they are found in places to which the light of day never penetrates. They are very often coloured with red ochre and other simple pigments, and they display in spirit and drawing a skill and sureness of touch which would do credit to any artist of to-day.

While on the subject of art it may be well to finish with this matter, as it concerns all the peoples of the younger palæolithic epoch. It was not merely pictorial art which they practised; they etched pictures—for example, the well-known illustrations of mammoths and elephants to be found in all books on the prehistoric age.[1] Thus we have an entire gallery of zoological illustrations of the animals of that far-off date, drawn by contemporary artists and without doubt most faithful representations. We shall shortly see that we know exactly what the mammoth was like, having seen him in a preserved condition: we should have had an almost equally good idea of his appearance from the different contemporary pictures of him which have been discovered. It perhaps hardly needs to be said that the preservation of these works of art is due to the fact that they were not executed on canvas nor on panels of wood (or if any such there were, then they must long ago have perished) but on stone and on bone: one of the pictures of the mammoth, for example, is executed on a fragment of his own tusk. Bone, ivory, and horn were, during the younger palæolithic period, favourite materials for the construction of implements, and these implements were quite generally ornamented: in other words, applied art had its birth at this time as well as purely pictorial art.

[1] Apart from the ordinary text-books on the subject of the prehistoric age and the large monographs which have been published about the discoveries in the caves, attention may be called to a work by Spearing, entitled "The Childhood of Art," published by Kegan Paul in 1912, in which, besides an account of the objects in question, there will be found a large number of representations, coloured and otherwise, of the pictures of these bygone races; also Parkyn, "Prehistoric Art," Longmans, 1915.

This ornamentation was sometimes only of an incised character, sometimes it was in relief, sometimes in the full round. It was applied to various objects, such as those curious holed pieces of reindeer horn called in most of the books "batons de commandement," which may possibly have been used as dress-fasteners. It is also applied to poignards or daggers of horn. One of the most remarkable examples is that of a long dagger of reindeer horn the handle of which forms one piece with the blade. This handle represents a reindeer in full flight : his fore-legs are tucked away under him so that they do not interfere with the grip, nor do his hind-legs, which are stretched out behind him, whilst his crupper makes an excellent pommel for the support of the hand. The carving is in the full round, and the weapon is not only beautiful but was probably also serviceable. In fact, when one considers the sharpened pieces of flint which were the only tools of the artist, we have in this example a piece of work which any atelier of to-day might be proud to turn out.

One curious feature remains to be pointed out, and it is one which in itself illustrates the similarity between these early savages and the savages of to-day or of yesterday —this is their unskilful treatment of the human form. In this respect the history of the race seems to repeat the history of the individual; for it is known to all that children who may make quite efficient attempts to represent other objects, fail, as a rule, completely when they attack the problem of representing the human form. Such certainly is also the case with all primitive races. Still the people of this remote age did try to represent the human form, both in outline and in figurines, and we gather from these that their physical conformation was like that of some African races, notably the Hottentots. Rude as the representations are, this fact is sufficiently obvious, and it forms a link in a chain of argument as to the modern representatives of these peoples on which a few words must shortly be said.

Two deductions may be drawn from the extraordinary outburst of art to which we have been calling attention. First of all it exemplifies the high intellectual characteristics of the people, and that point scarcely requires to be emphasised.

But it also shows that to some extent at least the struggle for existence must have become less intense. When man is engaged every moment of his life in a deadly fight for life he cannot find time to ornament the tools with which he makes existence possible. The fact that he can spare time for this, points to a certain relaxation in the extreme struggle for existence.

Let us note, in concluding this brief account of the art of the Palæolithic period, the puzzling fact that in the Neolithic period which succeeded to it, though after a gap as to which something will be said in the next chapter, there is no trace of any kind of art. It is curious, but there is no greater fallacy than that which attributes to the human race always and everywhere a continuous tendency to progress.

The SOLUTREAN period, which is sometimes included in that which has just been under consideration, is by others separated from it for this amongst other reasons—that the working of stone, so far as the Palæolithic Age goes, here attained its maximum: indeed some of the implements of this period are perfect marvels of craftmanship.

The MAGDALENIAN period marks a decline in the working of stone, though great skill was still exhibited in that direction. But it is *par excellence* the period of skilful work in horn and in bone, the horn of the reindeer being used for a variety of purposes. Further, it may be said also to have seen the high-water mark of art; for many of the best examples, notably the reindeer-dagger described above, belong to this period, as well as a number of the etchings of animals which show a vivid appreciation of nature.

The TOURASSIAN period may be looked upon as the end of the Palæolithic Age, or the commencement of the transition to the Neolithic. Whichever theory one adopts it is certain that workmanship in stone very much declined. Further, it would seem that the reindeer was deserting the districts over which he had up to then roamed and that his place was being taken by the red deer. The result of this is to change fundamentally the type of horn implement.

The reindeer has a solid horn which can be shaped into tools of various kinds, just as a solid stick can be whittled

into a small flat shovel or a pointed shaft. But the red-deer horn is hollow, so that only the side of it can be employed for the manufacture of flat or very slightly curved implements. There is the same difference between the two that there is between a length of elm or oak and a length of bamboo, and the difference between the two is reflected in the difference of the implements constructed. The most characteristic amongst these are harpoons barbed on one or both sides and formed from a piece of reindeer's horn, with which the capture of fish was effected.

Having now considered the various finds whether skeletons or implements, and the diverse zones of civilisation met with during the Palæolithic period, we need not follow any further the history of man on the earth.

We may now with advantage turn to the consideration of the relation of the races with which we have been dealing to the Glacial Period, the account of that period having been deferred, it will be remembered, until it could be linked up with the history of the men who belonged to it. But before passing to this part of our subject there are one or two matters which may be cleared up. In the first place, it may reasonably be asked what became of these early races? Did one zone fade or develop into another, or did one group disappear before another took its place? If so, what became of these disappearing peoples, and where did they disappear to? Were they wiped off the face of the earth or did they desert their former homes to seek refuge elsewhere? It is not possible to do more than touch upon these complicated and most difficult questions here. They will be found to be discussed in Sollas's "Ancient Hunters," a book from which quotation has already often been made in these pages. His views are thus summarised by himself: "If the views we have expressed in this and preceding chapters are well founded," he says, "it would appear that the surviving races which represent the vanished Palæolithic hunters have succeeded one another over Europe in the order of their intelligence; each has yielded in turn to a more highly developed and more highly gifted form of man. From what is now the focus of civilisation they have been one by one expelled and driven to the uttermost parts of

the earth: the Mousterians survive in the remotely related Australians at the Antipodes, the Solutreans[1] are represented by the Bushmen of the southern extremity of Africa, the Magdalenians by the Eskimo on the frozen margin of the North American continent, and as well perhaps by the Red Indians."[2]

The greater part of what has been said in this and the preceding chapters, and indeed of what will be said in the next, relates chiefly to discoveries made and theories relating to Europe. This must necessarily be the case, since at present at any rate the discoveries made there are more considerable than those which have so far emerged elsewhere, and the zones of civilisation are more numerous and better defined. But we must not pass from the subject without a few words as to some discoveries on the other side of the Atlantic.[3] Of these it would appear as if the "Nebraska loess men" have the best claim to antiquity, and they are probably much later than many of the remains which have been discovered in Europe. According to Dr. Hrdliçka the features of this race differed in no way from those still to be found amongst Indian tribes. The Lansing (Kansas) skull appears to belong to the same period. The celebrated Calaveras skull is of modern type and Mongolian in character. It is utterly

[1] With whom must, of course, be taken the Aurignacians, who seem to be linked by their cave-art, as well as by the female physical characteristics exemplified in their figurines, with modern African races.

[2] It may be convenient to set down here for purposes of reference some of the leading sites in England associated with the zones of civilisation dealt with in this chapter. Chelleo-Mousterian:—Alluvium of the Thames, Ouse, and Avon; Kent's Hole Cave, near Torquay in Devonshire; Robin Hood's Cave, near Creswell in Derbyshire; Brixham Caves and Wookey Hole in Somerset. Of this last a very complete account has been published by Mr. Balch (Oxford University Press, 1914). In an introductory summary by Professor Boyd Dawkins, which deals with the early men of this part of England, the writer points out that Mr. Balch's discoveries have established the fact that the cave-dwellers of Wookey Hole and the lake-dwellers of Meare and Glastonbury belonged to the same race and were both of pre-Celtic stock. These statements, which have not as yet had time to be subjected to full criticism, may have an important bearing on the Hiatus question which will be discussed in the next chapter. Aurignacian: Paviland Cave in Gower. Solutrean: Robin Hood's Cave, Church Hole Cave, both these near Creswell, Kent's Hole. Magdalenian: Robin Hood's Cave, Church Hole, and Kent's Hole.

[3] For a full account of these the reader may be referred to Dr. Ales Hrdliçka, "Skeleton Remains of Early Man in North America." Bureau of American Anthropology, Washington, 1907.

impossible that it could have belonged to the formation (Miocene) in which it was found. The man of the Arkansas loess is of Indian type, with a low forehead sloping back to a high crown. The oldest type of man found in South America, during excavations for docks at Buenos Aires, appears to be identical in character with the Arkansas man.

CHAPTER XXIII

THE GLACIAL PERIOD

THE period of the earth's history which is to be discussed in this chapter is one of the greatest interest and importance in relation to the questions raised in this book, since it is intimately associated with the appearance of man. Indeed it is only through a consideration of the problems of time associated with the Glacial Period that it may be possible, if indeed it ever is possible, to arrive at a conclusion as to the number of years which have elapsed since man first came into being. Like many other great problems of science, what is known about the Glacial Period is no doubt considerable, but what is still matter of surmise is far larger. We shall try to point out what is sure and what is still matter of dispute.[1]

In the first place, then, no kind of doubt need be entertained that large parts of the world during the Pleistocene Era passed through a period or periods of extreme cold, during which vast tracts of the earth were covered with enormous glaciers—tracts of the earth which are now enjoying an ordinary temperate climate or even luxuriating in still warmer conditions.

It is further quite certain that this period was not one of continuous and uninterrupted cold, but that it was diversified by epochs of a milder character, during which

[1] This chapter is for the most part drawn from the following, the most recent works on the subject: Sollas, "Ancient Hunters," Macmillan, London, 1911; G. F. Wright, "Origin and Antiquity of Man," Oberlin, Ohio, 1912; J. Geikie, "Antiquity of Man in Europe," Oliver and Boyd, Edinburgh, 1914; W. B. Wright, "The Quaternary Ice Age," London, Macmillan, 1914. After this acknowledgement it seems unnecessary to assign each of the statements in this chapter to the author from whom quotation is made, save in the cases where there is wide discrepancy of opinion and where it is therefore advisable that the reader should know by whom any given view is supported.

the glaciers retreated and areas, formerly frost-bound, became once more capable of supporting life; these milder epochs being again succeeded by glacial conditions. Indeed, there is nothing to prove that we may not now be in enjoyment of an inter-glacial epoch of mild character, nor anything to show that the glaciers may not once more invade those parts of the world where they are now and have for ages been unknown, and by their invasion eradicate in the areas invaded all traces of the civilisation of which we are now so proud. There is nothing to prove this to be a dream; and this because so far we are wholly in the dark as to the cause of that Ice Age which we know to have existed. It is hardly necessary to say that a number of theories have been put forward to account for the extraordinary difference of the temperature which must have existed at that time when compared with that which obtains at the present day. It has been suggested that it may have been due to a variation in the internal heat of the earth, but that does not explain the intervals, still less does it explain why we are not under glacial conditions at this moment. It has been supposed that the sun may be a variable star and have periods of darkness during which glacial conditions would obtain; or again that it has yellow or warm periods, and red or cold. There is no real proof that these theories have any kind of foundation. The idea that the Glacial Period was due to the passage of the earth through colder regions of space seems to be untenable. Changes in the distribution of land and water have been invoked as an explanation since the days of Lyell, but the most recent researches seem to throw very grave doubt on this explanation. The theory that the changes in climate are due to variations in the amount of carbon dioxide in the atmosphere has also been put forward, but has failed to meet with any general acceptance. There is also a group of explanations based on the effects of the variation of the elements of the earth's rotation and orbit, such as variations in the obliquity of the ecliptic, which, it now appears from careful calculations, could not produce any marked climatic changes.

Possibly a more likely explanation is that of Hann, who holds that "the simplest and most obvious explanation of

great secular changes in climate, and of the former prevalence of higher temperatures in the northern circumpolar region, would be found in the assumption that the earth's axis of rotation has not always had the same position, but that it may have changed its position as the result of geological processes, such as extended rearrangements of land and water." This view, which recent observations seem to have shown to be more tenable than was thought to be the case when it was first formulated, is still under discussion, but cannot be said to have secured anything like general acceptance. Croll's Astronomical Theory has perhaps secured greater acceptance than any other explanation so far brought forward. It has its difficulties, but they are perhaps less than those with which other explanations are confronted; but it would be too much to say that this theory is in any way to be regarded as established. It is briefly as follows :—

All the planets, the earth included, revolve around the sun, not in a circle but in an ellipse, and the sun occupies one of the foci, not the centre of this ellipse. At one end of its orbit (in perihelion) the earth is much nearer the sun than it is in the other (in aphelion). Further, the earth's axis is tilted so that in its journey around its orbit it presents first one then the other of its hemispheres more directly to the sun's rays, and at this time it is the southern hemisphere which is presented during perihelion and the northern in aphelion, but this was not and will not always be the case. Now, without going further into this matter[1] it may briefly be said that Croll's Theory refers the glaciation of Northern Europe and America to a time or times when, the eccentricity of the earth's orbit being considerably greater than at the present day, the northern summer occurred in perihelion.

It is not exactly waste of time to have briefly considered all these explanations, since they form a good example of the careful manner in which problems of this kind are considered by men of science, and further and even more fully demonstrate the extreme difficulty of assigning a reason

[1] This is fully discussed in Chapter XIV of W. B. Wright's "Quaternary Ice Age."

for many events of the occurrence of which we can entertain no reasonable doubt; and that even though we are in possession of so many of the terrestrial, astronomical, and mathematical data on which the explanation so long sought and so elusive must necessarily rest.

Any text-book on geology will explain the indications on which are based our knowledge of the districts which have existed under glacial conditions during the period in question, and how we are able to indicate the direction and ascertain the thickness of the sheets of ice. In the words of Sollas, if we follow the southern boundary of the ice, we shall find that it will take us out of Britain and lead us right across the continent of Europe. After stretching from Kerry to Wexford, and through the Bristol Channel to London, it crosses the sea, continues its course through Antwerp, past Magdeburg, Cracow, Kiev, runs south of Moscow to Kazan, and then terminates at the southern end of the Ural mountains. All that lies to the north of this line—the greater part of the British Isles, Northern Germany, Scandinavia, and almost the whole of European Russia—was buried out of sight beneath a mantle of ice formed by the confluence of many colossal glaciers. At the same time a large part of North America was overwhelmed. The great terminal moraine which marks the southern boundary of the ice can be traced with occasional interruptions from Nantucket, through Long Island past New York, towards the western extremity of Lake Erie, then along a sinuous course in the same direction as the Mississippi; then it follows the Missouri as far as Kansas City, and beyond runs approximately parallel to that river, but south of it, through Nebraska, Dakota, Montana, and Washington, where it meets the coast north of Columbia river. Within this boundary nearly the half of North America was buried beneath a thick sheet of ice, flowing more or less radiately outwards from a central region situated in and about the region of Hudson Bay. The coexistence of two continental ice-caps, continues the same writer, one on each side of the Atlantic Ocean, is a sufficiently impressive fact, and that the Ocean itself enjoyed no immunity from the rigours of the time is shown by the discovery of boulders, which appear

to have been carried by ice, in close proximity to the Azores (about lat. 38° N.). A review of the evidence may fairly lead us to conclude that a general lowering of the temperature, probably to the extent of about 5° C., affected the whole of the Northern Hemisphere which lies outside the Tropic of Cancer. We need not delay over the case of the Southern Hemisphere further than to state that it also presents its traces of a Glacial Period. In the regions which we have more particularly been considering, the ice sheets were of enormous extent, covering something like two million square miles in Europe and about double that in North America. They were also of enormous thickness, as the average depth of the European sheet has been calculated at one mile and that of the North American at from one to three miles. G. F. Wright remarks that the ice was certainly more than one mile deep over New England, for marks of the movement are found on the summit of Mount Washington, which is more than six thousand feet high. It is quite obvious that during this period when such tracts of ground were covered by such enormous masses of ice no kind of life could have existed. But it must be remembered that the ice was not omnipresent, for there were areas of Europe and of America which were not invaded. G. F. Wright, who is one of the champions of a recent date for the Ice Age, even goes so far as to say that " large areas in Europe and North America which are now principal centres of civilisation were buried under glacial ice thousands of feet thick, while the civilisation of Babylonia was at its heyday." It may at once be admitted that this view, which will be further considered shortly, is one which would not be accepted by at least a very large number of glacialists, but it will serve to impress on one's mind the undoubted fact that at certain periods of the Ice Age mankind must have been in existence on some part of the earth whilst other parts were covered with the immense crusts of ice with which we have been dealing. But further, there seems no doubt that the Ice Age was not an era of unbroken and unvarying cold. On the contrary, there were intervals—how many is still in dispute—during which warmer climatic conditions prevailed, the ice receded and human existence

became possible in regions where before—and afterwards—it was quite inconceivable. Here again it must be admitted that there is not a unanimous opinion in favour of the existence of genial intervals—still less is there a general consent, even on the part of those who believe in them, as to the exact number and relations of these intervals—but the most generally received view will now be indicated, together with the chief divergences therefrom. To this it will be convenient to add the relationship of man, according to various authorities, to the different subdivisions of glacial time. In a former chapter we dealt briefly with the geological history of the earth down to and including the Pliocene era which we saw was, on the whole, a time of considerable warmth, the temperature gradually becoming cooler towards its later part. On this followed the Pleistocene era, which is conterminous with the glacial epoch.[1]

There are, as has already been said, differences of opinion on the question, but the generally received idea is that there were during the Glacial Period four periods of intense glaciation, with three milder intervals. Each such milder interval would, of course, be preluded and led up to by a time when the glaciers of the preceding period of glaciation were receding, and in like manner would be terminated by a period during which the glaciers were gradually resuming their sway. The last period of glaciation was succeeded by the recent period—perhaps itself only a genial interval to be followed by further glaciation—in which we are now living.

Various names have been given to these periods; perhaps the best known classification is that of Penck and Bruckner, which is founded on alpine studies and is named accordingly, *Die Alpen im Eiszeitalter*.[2]

[1] In the following account use has been made of the works below indicated and the initials added in brackets after each will be employed for the purpose of avoiding unnecessary repetition. These works may be consulted by persons desirous of obtaining fuller information on the subject. Hoernes (H.), "Der Diluviale Mensch in Europa," 1913; Sollas "Ancient Hunters," Macmillan, 1911; Wright, G. F. (G. F. W.), *ut supra*; Geikie, Jas. (G.), "The Antiquity of Man in Europe," Oliver & Boyd, 1914; Wright, W. B. (W. B. W.), "The Quaternary Ice Age," Macmillan, 1914. This chapter has appeared in a modified form in my "Century of Scientific Thought."

[2] P. and B. in the table.

First Glacial Period. *Scanian* (G.), *Günz* (P. & B.).

This was a period of intense cold. In Britain no records exist, since they have either been destroyed or buried under later glacial formations.

First Inter-Glacial Period. *Norfolkian* (G.), *Günz-Mindel* (P. & B.)

At this time Britain was joined to the Continent of Europe by land-bridges; the continuity between the two now separate portions of land may perhaps best be illustrated by saying that the Thames was a tributary of the Rhine. The animals of this period were very different from those now or in recent times in existence in Europe;[1] for amongst the fauna were the hippopotamus, two kinds of elephant (*E. meridionalis* and *E. antiquus*), the bear, the bison, and the sabre-toothed tiger. It is possible that the sand-beds of Mauer in which what is commonly known as the Heidelberg mandible was found may belong to this period, for Geikie states that "the geological and palæontological evidence, although not quite decisive, seems to favour the reference of this ancient human type to the first Interglacial or Norfolkian stage."

Second Glacial Period. *Saxonian* (G.), *Mindel* (P. & B.).

As the ice receded at the termination of the second glacial period, Europe became subject to what are called "tundra" conditions—the word tundra, which is Russian in its origin, is applied to the flat plains which border the Arctic regions alike in Europe, Asia, and North America. Treeless and in many places marshy, they endure long periods of frost during each year, followed by others of cold winds, with relaxations during which scanty and stunted vegetation makes its appearance. When, therefore, one speaks of "tundra" conditions in Central Europe, one refers to a climate and other conditions similar to that experienced to-day in a large part of Siberia. It is obvious that

[1] It will be obvious that the account given in this table is based on European data. This is because the questions of chief interest in this connection, which relate to man and his appearance on this earth, are at the present time mainly associated with European discoveries.

conditions of this kind must exercise a great influence on the animals and plants at that time striving to exist in the area in question: indeed it is largely by considering the character of the fauna and flora that we are able to come to a conclusion as to the nature of the climate with which they must have been associated. Prominent amongst the fauna were the woolly rhinoceros, the musk-ox, the mammoth and the reindeer. Two of these creatures are of such importance that a few words must be said about them. The Mammoth (*Elephas antiquus*) was a huge elephant, differing from the elephants now in existence in various ways, but notably in size; in being clad with hair, some of it no less than six feet in length, which enabled it to withstand the rigours of a climate unsuitable to the elephants of to-day; and in the enormous upturned tusks which it possessed. This creature is not merely known to us by its skeleton, as is the case with so many extinct animals. It comes under our notice in two other ways. First of all, as stated in a previous chapter, it was the object or one of the objects of the art of early man, where we have vivid and unmistakable representations of this creature by his human contemporary. But beyond this, it has been possible for man of the present day to see this huge beast as he was in the days when he wandered over Europe, for in the course of those wanderings in what is now Siberia it was not infrequently his misfortune to become bogged in a temporarily-thawed ice and mud bed. Unable to extract himself from the trap into which he had walked, he perished in it and was subsequently frozen up and retained in that frozen condition—exactly like meat in cold storage—until long ages afterwards an unusually warm season thawed him out in such perfect condition that it has been possible to discover, by dissection, the remains of his last meal (pine tops) in an almost unaltered condition in his stomach. The reindeer, the other animal of interest, requires no special description, since being still in existence in northern latitudes it is familiar to everybody from pictures. It will suffice to point out that during the time with which we are now concerned and for many years afterwards this creature was to be found all over the Continent of Europe.

Second Inter-Glacial Period. *Tyrolian* (G.) *Mindel Riss* (P.).

When the Tyrolian period had been fully established the climate of Europe was milder even than it is at present ; and as a consequence, the snow-fields and glaciers of the Alps were much less extensive than they now are, a fact which throws a remarkable light on the conditions which then prevailed. The physical geography of Europe was very different from that of the present day, for land-bridges connected that continent with Africa and with the British Isles of to-day. At that time, it must be remembered, what are now Britain and Ireland were continuous land—indeed what may be thought of as the Continent of Europe extended some considerable distance west of what is now the further shore of Ireland.

The fauna differed remarkably from that of recent times for "the hippopotamus, elephants, rhinoceroses, cervine and bovine animals and many carnivores ranged over the major portion of Europe" (Geikie).

An excellent example of the difference in this respect may be found in a consideration of the facts learnt from the study of the Victoria Cave near Settle in Yorkshire—a place which has afforded shelter to man and beast for many, many centuries down at least to the time of the Saxon invasion, when the unhappy Celt, flying from the face of his foe, made it his place of refuge. It is but a few miles from Harrogate, where these lines are being written, and it is safe to say that no larger wild mammal than a fox would now be discoverable in its vicinity. At the time with which we are now concerned there were, as the remains show, the hippopotamus, the rhinoceros (though not the woolly variety), the straight-tusked elephant, the bison, the red-deer, the hyæna, and other animals which need not be mentioned; and with them and, as far as he could, no doubt on them, lived man, who was, we may feel sure, but too often their victim as well as their hunter.

Which of the races of man with whom we have been concerned in former chapters may we look upon as having existed at this period ? This is a very pertinent question,

for we have now undoubtedly arrived at a time when we can consider prehistoric man as a race and not merely as a thing of fragments like the Heidelberg and perhaps the Piltdown or the Trinil remains.

There is a considerable difference of opinion on this matter, for Hoernes, who had already disposed of the Chelleans and even of the Mousterians by placing them in the previous genial interval, brings the Solutreans into this one. It may fairly be said that Geikie's view is one which commends itself more to the scientific opinion of the day, in spite of the deservedly high authority of Hoernes.

According to Geikie the Chellean civilisation was associated with this epoch. Their "rudely fashioned stone implements seldom occur in caves, but are often met with in the older Pleistocene river-drifts. From this it has been inferred that Chellean man probably lived in the open, for the climate was clement and equable, the seasons not being so strongly contrasted as in our days. The margins of the rivers were apparently favourite haunts of the race, the coarse gravels affording an inexhaustible supply of the stones required for implements."

At its zenith this seems to have been the warmest of the intervals and it was almost certainly also the longest. As the climate gradually grew colder, preluding the next glacial epoch, the hippopotamus, the straight-tusked and the southern elephants, migrated southwards. The last-named animal never returned. It was during this period of transition from genial interval to glacial conditions that, according to Geikie, the Acheulian civilisation flourished.

Third Glacial Period. *Polonian* (G.), *Riss* (P. & B.).

In the period of transition just alluded to and in the epoch now under consideration, up to what may be called its climax, Geikie thinks that "man of the Mousterian stage of culture had come to occupy the caves of north-west, central, and southern Europe. In England, Belgium, France, and Germany he was eventually contemporaneous not only with the mammoth and the woolly rhinoceros, but with the reindeer, glutton, arctic fox, and other members

of the tundra fauna." This period was not one of such intense cold as the Saxonian, in which, as already stated, the glaciers in England extended as far as the valley of the Thames; in the epoch under consideration they came no further south than the Midlands.

THIRD INTER-GLACIAL PERIOD. *Dürntenian* (G.), *Riss-Würm* (P. & B.).

During this genial interval the Alpine glaciers dwindled very much, as is shown by the following amongst many other facts. On the Ebenalp and at an elevation of 4800 feet is the cave of Wildkirchli, in which have been found implements belonging to the Mousterian zone of culture and with them evidences of a fauna amongst which are the cave-bear, the cave-lion, the wolf, the stag, and the ibex. Now it is to be noted that all these animals have also been identified in the Mentone caves where they are equally associated with Mousterian implements, as well as with the bones of the straight-tusked elephant, the broad-nosed rhinoceros, and the hippopotamus. This shows how mild the climate must have been even at the elevation of the Wildkirchli cave. With this period, as well as with that which immediately preceded it, Geikie associates Mousterian man, that rugged and hardy individual exampled by the man of the Neanderthal remains.

On the other hand, Hoernes places Magdalenian man in this period. We may pause for a moment to consider how very tentative are all the views which are put forward respecting this glacial period. According to the classification now commonly adopted Mousterian man belongs to the Middle, Magdalenian to the Younger Palæolithic epochs. At any rate there is little doubt that there is a considerable interval of time between them—some, as we shall see, would say tens of thousands of years; yet it will be observed that two authorities, both of great eminence, put them into the same era, a thing which both would admit is impossible. There is, as is only natural in a subject in connection with which new discoveries are being made every day, a constant shifting of position on all sorts of questions connected with the Prehistoric period; and the uncertainty of many—one

might almost say most—of the views put forward in connection with it is well exemplified by the conflict of opinions to which attention has just been called. To finish with this point, Hoernes not only introduces the Magdalenians into this period, but he goes further for he subdivides it into two parts. The first of these, characterised by the reindeer, is Magdalenian; to the second, characterised by the red-deer, he assigns the Tourassian and even the Asylian—that is to say, the transition civilisation, which chronologists who follow Penck would place at something like one hundred thousand years' distance from the Mousterians, and who, on the most modest and moderate estimates, were removed from them by many long centuries. There is a skeleton discovered in the Thames Valley, commonly known as the Galley Hill skeleton, concerning which there has been much discussion. Keith[1] assigns this skeleton to the period with which we are now concerned and remarks concerning it: "The first impression on examining the remains of this earliest known inhabitant of England is one of surprise, almost of disappointment; in all his features, with a few exceptions, he is so modern in build that we might meet him on the streets of London to-day and pass him by unnoted."[2]

FOURTH GLACIAL PERIOD. *Mecklenburgian* (G.), *Würm* (P. & B.).

This seems to have been a less severe period of cold than the preceding glacial periods. According to Geikie "the younger archæological stages—the Aurignacian, the Solutrean, and the Magdalenian—are closely related to this epoch, the mammalian fauna indicating, for the first-named stages, a somewhat cold climate (as in the cave at Mentone

[1] "Ancient Types of Man," Harpers, 1911, p. 32.

[2] A few lines above it was remarked that the fluctuating character of scientific opinion on the topics now under consideration was largely due to the constant stream of new discoveries which are daily being made known to us. Here is an excellent example of this fact. At the date, 1911, when the book was published the statement just quoted might have well been held to be correct, but the Piltdown skull, discussed in another chapter, has robbed the Galley Hill example of its distinction, if scientific opinion is correct, and may itself be thrown into the shade, comparatively speaking, any day by some new discovery. However this may be, the age and characters of the Galley Hill specimen are very noteworthy.

and elsewhere), and for the Magdalenian even colder conditions. Probably the first-named stages should be assigned to the dawn of the Wurmian—to the period of transition from the preceding inter-glacial epoch, while the Magdalenian belongs essentially to the succeeding glacial epoch."

Magdalenian man is traceable, either skeletally or by means of his implements, all over the Continent of Europe: he is to be met with in England, Belgium, Germany, Switzerland, Austria, Russian Poland, etc. This does not necessarily mean that he inhabited all this area at the same period of time. What is quite probable is that as the climate grew colder he migrated further south to middle Europe, where it would seem that tundra conditions then obtained.

The Recent Period

As the intense cold of the true glacial epoch passed away, conditions similar to those which we now experience came into existence and have since continued. It has already been pointed out that we may be merely enjoying an interval between two glacial periods. We may or may not be at the maximum of the interval; probably not, as it would seem that the glaciers of the Alpine region are still in a stage of regression. The speculation is not a very practical one, but it may tend to engender a feeling of humility if we reflect that there is really no apparent reason why conditions may not occur under which the forces of nature will once more assert themselves, the gigantic glaciers reappear and wipe off the face of the earth every trace of the civilisations of Europe and North America.

So far we have been endeavouring to link with one another the stories of the glacial period and of man's relation to it, and we have seen how many difficulties that task presents and how diversely it has been accomplished by different authorities. We now arrive at a period when difficulties, at present apparently insuperable, have to be confronted, and of these it will be necessary to take stock.

The Magdalenian civilisation is a definite thing, clear-cut and easily recognisable; the same may be said of the

Neolithic civilisation which succeeded it. But the remarkable thing is that the two seem to show little if any relationship to one another. This is an unexpected condition of affairs, for there is no difference to account for it in the character of the materials used: there is, however, a greater break than that which occurred when metals came into use. Moreover, there seems to have been also, in Europe, or, at any rate, in Northern Europe, a complete contrast in climate and in fauna. These points may be illustrated by a table of contrasts prepared by W. B. Wright:—

Magdalenian	Neolithic
Poorly developed Stone industry.	Highly developed Stone industry; art of grinding and polishing stone.
Remarkable skill in drawing and etching.	Absolutely no pictorial art.
Hunting and fishing the only occupations.	Agriculture and the keeping of domestic animals.
A cold fauna with reindeer and mammoth.	The fauna of the present day.

It is quite clear from a consideration of this table that we have to do with two perfectly distinct and unrelated races living under totally different conditions and amongst dissimilar surroundings. It is inconceivable, for example, that the wonderful art of the Magdalenian period should have passed suddenly and completely out of existence, leaving no trace of its former luxuriance, had there been a continuity of race. The fact is that there seems to have been no continuity and no link between these two civilisations—so much so that this time is commonly spoken of as "The Hiatus." Of course it will be admitted that somewhere or another the gap must have been filled up, for no one has ever suggested that there were two inhabitations of the earth by races of men unrelated to one another. But what at present seems to be undeniable is that in the northern parts of Europe palæolithic man did disappear off the face of the earth, which was left without human inhabitants for a lengthy period during which the physical

conditions as well as the character of the fauna were profoundly altered.

"It is beyond question," says W. B. Wright, "that in post-glacial times neither Ireland, Wales, nor the northern half of Great Britain were occupied by man until the long subsequent Neolithic invasion. Even the south of England affords evidence of this general exodus, for here there is a complete break both in stratigraphical relations and style of workmanship between the implements of the two periods. Between the Palæolithic and Neolithic culture of Great Britain there is a great gulf fixed, and no amount of research has succeeded in finding any trace of a transition between the two."[1]

At the present moment—in spite of efforts to show some trace of a transition at Larne in Ireland, at Cissbury in England, and elsewhere—the statement just quoted must stand as true. It is, however, more than probable that this difficulty will be completely cleared up, possibly at a very early date, by the numerous scientific excavations now taking place in so many parts of Europe. Indeed there is little doubt that Piette has discovered in the Grotto of Mas d'Azil in France a series of zones which demonstrate the transition stage with which we are now dealing. From this grotto the zone of civilisation which we may look upon as transitionary between the Palæolithic and Neolithic Ages has been named Asylian; it is also called Tourassian; and other transition periods have been denominated Campignian, Tardenoisian, and Arisien. Over these matters we cannot linger, but must content ourselves with noting the fact that there is at present a hiatus in most parts of Europe between the two great epochs of civilisation, which hiatus we take, by actually observable evidence, to have been bridged in certain spots in southern Europe. There is, however, a difference of opinion as to when exactly this Transition period was in existence. Hoernes, who, as we have seen, pushes back all his races, assigns the Transition (Asylian) period to the Fourth or Mecklenburgian glacial epoch, which would bring the true Neoliths in at the commencement of the present or fourth genial era. Geikie, on

[1] "The Quaternary Ice Age," p. 78.

the other hand, places the Asylian period in the present genial epoch, thus throwing the Neolith nearer to our own day. There is little doubt that the majority of prehistoric archæologists would agree with him.

Having thus endeavoured to sketch the history of the Pleistocene epoch both geologically and anthropologically, we must next turn our attention to the exceedingly vexed questions of the age of the earth and of the age of man upon it.

CHAPTER XXIV

THE AGE OF THE EARTH AND THE AGE OF MAN ON IT

THERE is perhaps hardly any problem connected with geological science which has been more widely debated, or in relation to which more widely divergent opinions have been arrived at, than that which is concerned with the age of the earth; and more especially with that part of its existence, very small in comparison with the whole, during which it has been inhabited by man.

No one need spend time in wondering why a question of this kind should interest men of science: it is less obvious to the general reader why the problem should offer such almost insuperable difficulties. That it does so is proved by the enormous discrepancies of the results arrived at—a fact which will be obvious to anyone at all conversant with the literature of the subject.

In order to regulate our own doings we must have some measure of time—whether that measure be a watch or a clock or whether we content ourselves with observations of the sun or of heavenly bodies.

In like manner, in order to estimate the progress of time in connection with the history of the earth, we must also have some kind of measure—a "geological clock": and this is exactly what geologists have been looking for, so far without any very conspicuous success.

A ship, which is lost unless it has an accurate timekeeper on board, carries one or more chronometers supposed to be absolutely faithful recorders of the passage of time. Even the domestic clock is of little use to its owner unless it keeps time; the difficulty with most geological clocks is that we cannot feel sure that they do keep time, nay more, we can

feel almost sure with regard to them that they do not—that is, that they have been "slower" or "faster" in the past than they now are. One or two simple examples will suffice to explain what is meant, and to illustrate the difficulty there is in estimating even recent geological time.

Rivers carry down to the sea a certain amount of detritus every year: this is measurable and has been carefully measured in the case of some rivers, notably and most carefully, for example, in the case of the Mississippi. This detritus, being obtained by the wearing away of the bed of the river, causes a slow deepening of the gorge in which the river runs. It would seem to be an easy matter to estimate the age of the river by a rule-of-three sum: a moment's reflection, however, will show that unless we are quite certain that the annual amount of detritus carried away is a constant quantity, our calculations may be wholly incorrect. But, it may be argued, it is easy to take an average over a number of years. This might be possible if we had some thousands of years' records on which to work instead of fifty or sixty at the most. Even then it would not give us an absolutely accurate estimate, for we should still be uncertain whether the conditions in earlier ages had not been wholly different from those of the time during which observations had been made. In the immediate post-glacial period, for example, when enormous glaciers were in process of melting, immense volumes of water must have poured through the watercourses with correspondingly increased denudation and removal of detritus.

Again, take the rate of deposition of stalagmite.[1]

In Kent's Cavern, near Torquay, there may be seen at this day an inscription carved on a boss of rock which reads "Robert Hedges of Ireland 1688," and is perhaps the record of some fugitive of that troublous period. The existence of this cave had been forgotten for many years until it was rediscovered by a Catholic priest, Father McEnery, in the

[1] It may perhaps be explained that stalagmite is the calcareous concretion which often forms a floor, at times with fantastic upward projections, in limestone caverns, just as stalactite hangs stony festoons from the roofs of the same. Both are due to the gradual deposit of carbonate of lime dissolved in the water which slowly filters through the rock from the surface soil.

middle of the last century. When the cave was scientifically examined by the late Mr. Pengelly the inscription in question was found to be covered by a thin but measurable coating of stalagmite. The floor of the cave presented several feet of stalagmite. If it had taken two hundred years to form one-twentieth of an inch, or whatever it was, how many years would it take to form four feet? The question seems easy of answer, but it is not; for in another case, also in England, ginger-beer bottles were actually found under a foot deep of stalagmite. Here again the clock does not keep time. The deposition of stalagmite depends upon the amount of carbonate of lime in the percolating water; that to some extent depends upon the amount of carbon dioxide in the water, and that again upon the nature of the soil it passes through and the kind of vegetation which it carries. Thus neither of these apparently promising clocks really can be relied upon to keep time; and in greater or lesser extent this is also true of the many other "clocks" which from time to time have been proposed to the scientific world.

With this preliminary warning we may now turn our attention to some of the most recent observations which have been made upon this subject.[1] To begin with, we have to decide from what point of view we are going to commence to calculate the age of the earth. Whether it began as a nebular gas or as a nebular collection of planetesimals is of little consequence in this connection, for, so far as it is possible to see, there is no means of deciding how long ago either event may have taken place. Are we to calculate from the time when the moon was cast out of the side of the earth? As to that there is ample margin for difference of opinion, for Sir George Darwin estimated that this event might have taken place at any time between 50,000,000 and 100,000,000 years ago. We may perhaps with benefit con-

[1] For most of the facts, figures, and comments in the earlier part of this chapter I am indebted to a paper by Professor Joly, F.R.S., which appeared in the "Philosophical Magazine," September, 1911, and was republished, after revision, in the "Smithsonian Report" for 1911, pp. 271–93. The references in the text are to this publication. His book "The Birth-Time of the World," which appeared after this chapter was written, may also be commended to readers.

sider the age of the ocean, at which there really is some chance of arriving, and thus consider the age of the earth from the time of the separation of dry land from sea. This has been estimated by the calculation from solvent denudation. We must begin by noting that as the land was once all dry and the water deposited on it from the clouds, the first collections of fluid in the hollows—the future seas and lakes—were all distilled water untainted with salt of any kind. All the salts in the sea, then, must have accumulated since that period and must have been derived from the earth by the solvent denudation just mentioned. Our calculation then must depend upon the percentage of sodium in sea-water and be based on the average chemical composition of river water and the probable annual discharge of the rivers into the ocean. "The sodium which has reached the ocean has originated in the conversion of igneous into sedimentary rocks. It is easy to calculate from the composition of a generalised igneous and a generalised sedimentary rock and from the quantity of sodium in the ocean that the denudation of about 84 million cubic miles of sediment accounts for the sodium in the ocean. Such a quantity of sedimentary rock would, if all was now on the land, cover the present land area (55 million square miles) to a depth of little over one mile."[1]

No one denies that in calculating on this basis there are numerous opportunities for mistake, nor that corrections may have to be made in the future for points now foreseen as well as quite probably for others unknown at the moment. Subject to all these limitations—and it should ever be borne in mind that no one is more insistent than the scientific man as to the extremely tentative character of all such calculations—Professor Joly comes to the conclusion that "solvent denudation, estimated in the only manner open to us, assigns an age to the ocean which at its probable maximum does not exceed 100,000,000 years,"[1] and he adds: "It is against probability to add 50 per cent to this value. We can only double it by appealing purely and simply to the imagination for effects of which we possess no indication,

[1] Joly, p. 282.

and the existence of which is at variance with what we know."[1]

Another method of estimating the age of the earth is that by radioactivity, based upon the accumulation in minerals of the inert products—helium and lead. The rate of production of helium by a given amount of uranium may be regarded as known with considerable accuracy, says Joly; and from this and from the mass of lead generated annually per gram of uranium—assuming that lead is the final product of decay in the uranium series—it is possible to make an estimate of the age of the earth. Such an estimate, in view of the inchoate state of our knowledge of the whole subject of radioactivity, must be even more tentative than that which is based on solvent denudation. It is only mentioned here to show one more of the methods of attack to which this problem has been subjected.

The age of the earth has this bearing on the question with which we are especially concerned, in that the Pleistocene Period can only bear a certain ratio to the whole, indeed can only form a very small part of it; so that the longer or shorter period we allow for the whole will entail a longer or shorter period for the part.

This being so we may now turn our attention to the question of the maximum thickness of the strata deposited in the various geological periods as estimated in the subjoined table.[2]

	Feet.	
Recent and Pleistocene	4,000	
Pliocene	13,000	
Miocene	14,000	
Oligocene	12,000	
Eocene	20,000	
		63,000
Upper Cretaceous	24,000	
Lower Cretaceous	20,000	
Jurassic	8,000	
Trias	17,000	
		69,000

[1] Joly, p. 276.

[2] Sollas, Presidential Address to the Geological Society of London in 1909.

	Feet.	
Permian	12,000	
Carboniferous	29,000	
Devonian	22,000	
		63,000
Silurian	15,000	
Ordovician	17,000	
Cambrian	26,000	
		58,000
Keweenawan	50,000	
Animikian	14,000	
Huronian	18,000	
		82,000
Archean	?	
		335,000

Supposing that man was in existence during the entire of the Pleistocene and Recent Period, it will be seen from the above table how very small a part of the whole of geological time that must needs be.

Professor Joly has been kind enough to plot out for me Strutt's time (obtained by the radioactivity method) against Sollas's data (as given in the table above). By taking square paper and joining the Oligocene point to the present, which would be 0 in such a diagram, some idea of the subsequent periods should be got. On this calculation the beginning of Pliocene time would be about 3 or 3·3 millions of years ago, and the beginning of Pleistocene time about one million years ago. In considering these figures the reader must not fail to bear in mind that they are highly tentative and based on data which may require extensive correction and revision.

The matter of chief interest to us is the date of the advent of man: or, in other words, we are more concerned to learn what science has to say to-day on that subject than we are to ascertain the latest views as to the actual age of the earth itself. To this question of man and his date we may now turn our attention.

In what follows readers can scarcely fail to be struck by the amazing discrepancies which will be observed to exist

between the statements of different persons, all more or less authorities on the subject with which they are dealing. This at least clearly proves one thing—namely, that no real certainty, scarcely even any probability, can attach to any matter concerning which such extraordinary differences of opinion exist. There is, however, another point to which attention should be called and it is this: the writers to whom we have been alluding may be divided accurately enough into two classes, geologists and anthropologists—in other words, into those who have made the earth and its history their chief study and those who have devoted their attention chiefly to man and his history. It may further be remarked that, almost without exception, the more extravagant demands for time will be found to be made by anthropologists and not by geologists. The underlying reason for this is that most anthropologists believe that the body of man was evolved from that of some lower animal, and moreover believe that the process of evolution occurred by small variations taking place over a vast extent of time. They, therefore, postulate that vast extent of time.

A little consideration will show that this is a very unscientific way of going to work. If it were perfectly certain—if it were as clear as any proposition of Euclid—that the body of man had been evolved, and evolved by the slow process alluded to, and if it were equally clear that that process of evolution could not by any possibility have taken place in less than so many years, then indeed it would be allowable for the anthropologist to say to the geologist: "You must find me so many years since the advent of man, and if you cannot do so it is quite clear that your methods are all wrong." In a later chapter these questions will be considered, and it will be seen that the premises for such a conclusion as that indicated above are in no kind of way established.

Unless and until they are established, the question remains, and, it may be added, seems likely always to remain, a purely geological one, to be settled on purely geological lines. It is, therefore, to the geologists that we must turn, though it must be admitted that when we do so we find ourselves confronted by hopeless discrepancies

even there. One instance of the difference of opinion between geologists and anthropologists may here be cited as an example of the classes of statements of which I have been speaking. Mention has several times been made of the Mousterian race and of their interments at Chapelle-aux-Saintes. Professor Sollas, who is primarily a geologist though also a high authority upon anthropology—in fact one of the few men who can speak with real authority in either house—places these interments at a distance of 25,000 years from the present day. Professor Keith, on the other hand, who is an anthropologist of high standing but who certainly would not claim to be a geological expert, refuses to be satisfied with less than 350,000 years for the period which has elapsed since the Mousterians placed this particular dead man in his tomb. Nothing can better illustrate the points under discussion than this single example.

After these preliminary remarks we may devote a short space to the consideration of the time theories of different authorities and may commence by asking how long it is since the Recent Period, in which we are now living, came into existence. It is obvious that no fixed date can be given for this. There was no particular morning on which Prehistoric Man woke up to discover that the Mecklenburgian Glacial Epoch had come to an end and the present genial epoch had commenced. The passage from one to the other must have been slow and gradual, and the dates, therefore, at best can be but approximate.

The retreat of the glaciers was slow and the extent of Europe which they covered, even at their maximum, limited. During the whole of the same glacial epoch men and women were living and dying in other parts of the world, even in other parts of Europe: what were these people and what form of civilisation had they reached? G. F. Wright,[1] who has been a student of glacial questions for forty years and has published many important books and papers on the subject, as we have already seen, makes his view on the matter perfectly clear. His remarkable statement may be repeated: "Large areas in Europe

[1] "The Origin and Antiquity of Man," Oberlin, Ohio, U.S.A., 1912, p. 195.

and North America which are now principal centres of civilisation were buried under glacial ice thousands of feet thick, while the civilisation of Babylonia was in its heyday" —that is to say, some five to six thousand years ago. Further, he continues: "The glib manner in which many, not to say most, popular writers, as well as many observers of limited range, speak of the Glacial Epoch as far distant in geological time, is due to ignorance of facts which would seem to be so clear that he who runs might read them." Such a view does not differ very widely from that expressed by another distinguished geologist, Professor Sollas, who—after tracing backwards the history of mankind until it ceases to be history and becomes archæology, and that prehistoric—arrives at the Asylian Period, which, as we have already learnt, is now regarded as the time of transition between the Palæolithic and the Neolithic Ages; and states that "from this point—the beginning of the seventh millennium" (from the present date, of course) "we look backwards over the last glacial episode." On the other hand let us ask the same question of Penck, whose studies in glacial conditions in the Alps and whose numerous writings thereon justly entitle him to a place in the first rank of authorities. Penck thinks that the post-glacial period in which we are now living cannot possibly have lasted for less than 20,000 years—that is to say, he demands three times as long as Sollas and four times more than Wright.

A recent series of researches in Sweden seems at the present moment to afford some hope that a reliable time-scale may at last have been arrived at in connection with the point at issue—the end of the Ice Age. These researches have been made by de Geers[1] in the laminated marine clays of southern Sweden, which seem to mark off the years in much the same manner as the rings in the trunk of a tree. Assuming that this particular "clock" keeps time—and there is more reason to assume this than there is in the case of any other "clock" so far offered to us—de Geers claims that he is able to prove that it is 9000 years since the ground on which the University of Stockholm stands became free

[1] For an account of them see W. B. Wright, "The Quaternary Ice Age," Macmillan, 1914, p. 343.

from ice. The same authority claims to have also shown from the conditions observable in a post-glacial lake-bed in Sweden that the ice did not leave that particular region until about 5000 years ago. In all this we are not very far away from the statements of Sollas and G. F. Wright. It may reasonably be asked on what evidence writers such as the last named depend in coming to a conclusion as to dates.

One example has been cited in the marine clays and another much better known and more widely discussed is that of the Gorge of Niagara.[1] Like the majority of waterfalls everywhere, Niagara is itself a post-glacial object, as is proved by the fact that there is a buried pre-glacial channel leading from Lake Erie to Lake Ontario, some distance west of the present river. The gorge with which we are now dealing is at present some seven miles in length, and the strata by which it is bounded are such that Wright remarks of them that "no geological conditions could be more uniform and calculated to yield more definite results to careful study."

Here at any rate we have a promising "clock," for there is a definite distance to be measured; it is composed of rock so uniform in character that the cutting-through process ought to be fairly uniform, and there is no special reason to suppose that the volume of water has so varied at different epochs as seriously to affect the rate of erosion. Lyell, a most distinguished geologist, visited the Falls in 1842 and made a guess that the rate of erosion could not be more than one foot per annum, and probably would not be more than one-third of this or four inches. This statement is often cited as if it had been a fully reasoned view instead of the mere guess which it admittedly was: this is hardly fair to that very eminent authority. Lyell himself suggested that careful observations should be made, and from the date in question they have been made for sixty-five years, with the remarkable result that it has been proved that the average rate of erosion has been a little more than five

[1] A full account of this will be found in G. F. Wright's book, to which the reader may be referred for a very complete account of the evidence of various kinds on which the writer in question depends for the establishment of his thesis as to the recent date of the Glacial Epoch.

feet per annum—that is to say, more than five times Lyell's maximum and more than fifteen times his minimum. So that if, as here, at least, seems quite likely, the same forces have been at work continuously in the past that are operative at the present, Niagara River would have eroded the whole gorge in 7000 years. Wright, from whom this statement has been taken, adds a chronological table of the gorge which is so picturesque that its quotation may be permitted.

"With great confidence," he says, "we can locate the position of the Falls at different past historical epochs. For example, at the time of the Crusades the cataract was about one-third of the way down to the head of the rapids. At the time of the birth of Christ it was two-thirds of the way down to the rapids. When the Falls had receded to the head of the rapids, Rome was being founded and Greece was just entering upon her classical career. When the Falls were at the whirlpool, Israel was just entering Egypt, while the beginning of the Falls at Queenstown occurred only a short time before the building of the great pyramids, and the expedition of Sargon from Babylonia to the shores of the Mediterranean about 3800 B.C." The same evidence is obtainable from other falls, such as those of St. Anthony at Minneapolis, Minnesota, for an account of which and for much other interesting matter on this subject the reader may be referred to the work from which quotation has already been freely made. From this and from a vast amount of other evidence Wright concludes that the entire glacial epoch—the whole period, not merely the fragment of post-glacial time which we have been hitherto considering—this whole period does not extend to more than 80,000 years. Further he states, with regard to the period of man's habitation of the earth, that while his antiquity "cannot be less than ten thousand, it need not be more than fifteen thousand years. Eight thousand years of prehistoric time is ample to account for all known facts relating to his development." So far for the protagonist of a recent date: let us now turn to the conclusions of his opponents; and in so doing we will omit for the present all consideration of anthropologists and turn to a distinguished geologist

Penck certainly holds a high place amongst glacialists and is in no way chary of drawing large cheques upon the bank of Time. Now Penck demands for the genial intervals alone an enormous period of time—

For the Riss-Würm or Third (Mousterian man, Geikie) 60,000 years.

For the Mindel-Riss or Fourth (Chellean man, Geikie) 240,000 years.

We have already been asked for 20,000 years at least for the post-glacial period, so that we are now arrived at 320,000 from the present day without having made any allowance for the first genial interval, not to speak of the glacial periods which divided these periods from one another. These other areas must also be taken into consideration. "The data," says Geikie,[1] "for determining the duration of the First or Günz-Mindel Interglacial epoch are not so ample—all the evidence, however, leads to the belief that, while not so long as the Second, it was much longer than the Third Interglacial epoch. We may provisionally assume," he continues, "its duration to have been about 100,000 years, and we thus obtain 400,000 years for the first three interglacial epochs: to which we may add 20,000 years to cover the interstadial stages of post-Würmian times." Then we have still to allow for the glacial epochs themselves, and according to Professor Geikie for this purpose not less than 200,000 years are required, so that we must assume "a minimum of 620,000 years for the duration of Pleistocene times." We have here a very different conclusion from that previously quoted, though the same data were open to both experts. We have seen what the former thinks as to the period of time during which man has occupied the earth. From what has gone before it is obvious that Penck would give him a very much longer history, and such is indeed the case. "Quite recently Professor Penck has expressed the opinion that the Glacial Period with all its climatic changes may have extended over half a million to a million years, and as the Chellean stage dates back to at least the middle of the period, this would give somewhere between 250,000 and 500,000 years for the antiquity of man in Europe. But if,

[1] "The Antiquity of Man in Europe," Oliver & Boyd, 1914, p. 301.

as recent discoveries would seem to indicate, man was an occupant of our continent during the First Interglacial epoch, if not in still earlier times, we may be compelled greatly to increase our estimate of his antiquity."[1] Perhaps one may be permitted a parenthetic comment and question at this point.

Penck insists that we must go back some 200,000 years before we arrive at the times of Mousterian man, yet when we arrive at him we find him, as we have already learnt, in every sense of the word a man and a capable man too. He had many more difficulties to contend with than we have, and had, of course, many fewer advantages, but there is no reason to suppose that his intellectual potentialities were any less than ours of to-day. Again, according to Penck we may have to go back some 20,000 years for the commencement of the Neolithic era. It is less than 10,000 years—to follow the generous estimates which we are using —since the knowledge of metal came into existence—less than 4000 since iron became known. Some 6000 or 8000 years for the evolution of our present complicated civilisation, and what of the previous 190,000 odd years? What was the highly capable Mousterian man doing, still more what were the undoubtedly talented Aurignacians and Solutreans doing, that they made so little progress in such a vast extent of time? It may be asked what about the Australians and other such primitive folk? No doubt there are primitive and backward races, but the history of Europe, so far as we can see it, seems to fit in but badly with Penck's enormous vistas of time.

One thing is perfectly clear—that while there are such enormous discrepancies between the findings of diverse authorities no kind of reliance can be placed upon any of them. This, it should at once be admitted, is fully realised by the geologists themselves: "No geologist has over-much confidence in such estimates," says Geikie,[2] and adds that "they serve to give some precision to our conception of geological time"—in face of the discrepancies, not quite as much precision as one might desire.

[1] The quotations are from Geikie, *op. cit.*, pp. 302–3.
[2] *Op. cit.*, p. 300.

Before passing from this subject it may be added that whilst Dr. Obermaier is prepared to give 50,000 or even, in consideration of the Mauer jaw, 100,000 years for Palæolithic man in Europe, the Abbé Breuil, who is in the front rank of modern anthropologists, is prepared to assign a period of some 20,000 years for the sojourn of man upon earth; and that Prestwich, whose geological knowledge no one will deny, limited the entire Glacial Period to 25,000 years, and thus, so far as our present knowledge goes, limited the sojourn of man to a still smaller number of years. The practical lesson for the ordinary reader is this—that when he sees a statement in his daily paper that a certain skull or a certain implement of human manufacture which has recently come to light is several hundreds of thousands or even several million years old—the statements run into millions at times—he must remember that there is no sort of definite evidence for any such statement, and that all that it amounts to is that the object in question is (or may be) of quite a respectable antiquity.

Lastly, so far as this matter goes, we may ask how the Church views this question of chronology. In approaching that matter I shall not depend upon my own knowledge, but shall quote from recognised authorities. There is no question but that the period of man's appearance on the earth dates much further back than was supposed in pre-scientific days. But to the dates of those days the Church has never given her sanction. On this point the learned article on Chronology in the "Catholic Encyclopædia" may be quoted. When dealing with the Creation of Man its writer says: "The question which this subject suggests is: Can we confine the time that man has existed on earth within the limits usually assigned, i.e. within about 4000 years of the birth of Christ? The Church does not interfere with the freedom of scientists to examine into this subject and form the best judgement they can with the aid of science. She evidently does not attach decisive influence to the chronology of the Vulgate, the official version of the Western Church, since in the Martyrology for Christmas Day the creation of Adam is put down in the year 5199 B.C., which is the reading of the Septuagint.

It is, however, certain that we cannot confine the years of man's sojourn on earth to that usually set down. But, on the other hand, we are by no means driven to accept the extravagant conclusions of some scientists." With that conclusion all may agree.

Before closing this chapter attention may be called to the words of the Rev. Hugh Pope, O.P.:[1] "It is well to bear in mind that the Biblical chronological system is in no sense a scientific one, that its details are often conflicting, that starting as it does from the beginning when there can have been no means of dating events, it is possibly only meant as a guide to the memory and not as a clue to history." "On the other hand," he also states, "none of the dates assigned by scholars to the events of this early period can be regarded as more than approximate and should not be regarded as solid means of testing the Biblical statements. These latter, indeed, are as ancient as any other system of chronology which has been handed down to us."

[1] "The Catholic Student's Aids to the Bible," O.T., p. 21.

CHAPTER XXV

LIFE—VITALISM—MATERIALISM

IN order to complete that section of this work which is especially concerned with Geology, it has been necessary to touch upon some of the questions concerned with Primitive Man before the topic of his origin has been so much as mentioned.

This topic indeed is one to which we shall have to devote much attention. But before we can touch upon it it will be necessary to pass in review the various biological problems of interest to us in connection with the purposes of this work; and, as the term Biology itself demands, we must commence by considering the nature of Life, and must discuss the question as to its origin upon this planet.

In essaying this task, and especially the first part of it, we are confronted with perhaps the most difficult problem with which we have as yet been brought into contact: though, to those unacquainted with philosophical and biological writings, it may seem strange to suggest that there is any problem at all, let alone one of any significance or difficulty.

Let us approach the problem in the simplest possible manner and ask ourselves "Is there any difference between a man and a block of stone?" To this question there can be but one reply: "Of course there is." But when we ask our second question: "Is this difference one of kind or of degree?" the reply does not come quite so clearly nor so unanimously. Most ordinary people would reply: "Of course the difference is of kind, for one is alive and the other is not." Yet in that reply is involved the whole complicated question which we have to discuss; for it is that word "alive" which sums up the whole matter in dispute. Is

a thing which we call "alive" different *in kind* from what we call not alive? The ordinary man would at once reply: "Of course it is." And in the opinion of most learned men throughout the ages the ordinary man would be quite right. But we must now approach the question from a more technical point of view.

"What is Life?" What is a "living thing"? What is it that distinguishes a living from a not-living thing?

There have been innumerable attempts to define the indefinable—that is, Life: Fr. Maher gives a number of them.[1] Speaking of the scholastic definition of Life he says: "The scholastics defined Life as *activitas qua ens seipsum movet*—the activity by which a being moves itself. The word *move*, however, was understood in a wide sense as equivalent to all forms of change or alteration, including the energies of sentiency and intellectual cognition as well as local motion. The feature insisted on as essential is the *immanent* character of the operations. An *immanent* action is one which proceeding from an internal principle does not pass into a foreign subject, but perfects the agent. All effects of non-living agents are, on the contrary, *transitive*. Notwithstanding the multitude of attempts made by successive philosophers and biologists, the definition of the schoolmen has not been as yet much improved upon." In connection with this statement it must be borne in mind that the comment and *a fortiori* the definition were made before the internal activities of the atom were fully recognised, and it is possible that such recognition may require a modification in the definition, the truth of which will, however, in no way be altered.[2] Further definitions, quoted by the same author, are as follows: "Bichât's definition is well known: 'Life is the sum of the functions which resist death.' This is not a very great advance if death can only be described as the cessation of *Life*. 'Life

[1] "Psychology," p. 551.

[2] The internal activities of the atom, of which we know too little to dogmatise in any way, are in continuity, it has been suggested by a recent writer, with the internal and external activities of living things. Space does not permit of a discussion of this matter, but it may at least be said that the purely rhythmical inter-atomic movements seem to differ wholly from the purposive movements of living things and to have no more relation to them than the so-called Brownian movements.

is the sum of the phenomena peculiar to organised beings' (Béclard). 'Life is a centre of intussusceptive assimilative force capable of reproduction by spontaneous fission' (Owen). 'Life is the twofold internal movement of composition and decomposition at once general and continuous' (De Blainville, Comte and Robin). These definitions, starting from the physiological point of view, aim merely at summing up the phenomena of vegetative life and exclude intellectual activity. Mr. Spencer with his wonted lucidity defines life as 'the continuous adjustment of internal relations to external relations.'" When I read over these definitions and recognise the modicum of truth which each contains, I cannot think that any one of them—not to say all of them—is likely to be of much help to the general reader for whom this book is chiefly intended.

He will probably say that there certainly is *something* in a living being which there is not in a lump of stone. He will further, though less strenuously, argue that there is something more in any animal, giving that word its widest significance, than there is in a plant. Nor, as a rule, will he hesitate to admit that there is something in man which is not met with in any other animal.

Let us consider the first of these *somethings*: but before doing so let us make it quite clear that there is a school—a rapidly diminishing school, as we shall see—which denies altogether that there is any such "something"; which, on the contrary, argues that there is no difference of kind but merely one of degree between a man and a stone. To take one of the latest and most advanced of this school:[1] "Between life and death the difference is of the same order as that which exists between a phenol and a sulphate, or between an electrified body and a neutral body. In other words, all phenomena which we study objectively in living beings can be analysed by the methods of physics and chemistry."

There are, then, those who maintain that there is a "something," whilst there are others who deny it any existence. Before proceeding to bring forward arguments

[1] Le Dantec, "The Nature and Origin of Life," Hodder & Stoughton, London, 1907, p. 5.

in favour of our own view—that there is a "something"—we may devote a short time to considering the history of the Vitalistic struggle, since by so doing we shall find our study of the question itself somewhat simplified.[1]

We commence, as in most things, with Aristotle, "the master of all who know," as Dante calls him. Aristotle, into whose arguments we need not look, had no doubt that there was a "something" which he named an *entelechy*—a thing which bears the end in itself. This actuality Aristotle called the soul; but he distinguished between different kinds of souls or different stages of the soul which determined different stages of the organic creation. Thus according to his philosophy, plants possess for their lifetime, and animals at the outset of their career of life, only the nutritive soul which is the soul of growth and is identical with the generative principle which existed in the seed. But at a later period of growth, when they became recognisable as animals rather than as vegetables, animals became endowed with the sensitive soul with which was connected the appetitive; and this possession it was which marked them out as animals and distinguished them from vegetables. Men alone have the third endowment, Reason, which alone comes "from without" and is divine.

We need not trouble to work our way through the succeeding ages nor need we even delay over the Scholastics and their teaching. St. Thomas, whose work was so largely founded on Aristotle, put forward views which did not substantially differ from those already mentioned—in fact, throughout the centuries until that from which we have so recently emerged, no one of any authority doubted the truth of what is commonly called Vitalism.[2]

[1] For a recent account of the history of this discussion, from which, by the way, almost all mention of the Scholastics is omitted, the reader may be referred to Driesch, "The History and Theory of Vitalism," Trans., C. K. Ogden, Macmillan & Co., 1914. From this work most of what immediately follows has been taken.

[2] Whilst it may be admitted that there are objections to this as perhaps to almost any other descriptive term for the theory under consideration, we shall continue to use it as expressing the convictions of those who believe that in living beings there is a something not to be found in not-living matter. Fr. Maher's note on this term and on another ("Animism") frequently to be met with in discussions on these matters, may here be cited ("Psychology," p. 545): "Some modern authors

In fact, Driesch[1] points out that the old Vitalism died, or rather appeared to die and certainly became obscured, owing to the fact that it ceased to have any opponents. Its upholders became careless and unable to face attacks, even those of a not unjustifiable character; and above all they neglected to strengthen their position by showing the support which it gained from the new facts constantly being accumulated by biological workers. "Thus it was," he says, "that a critique came to the front which, to all outward appearance, had set Vitalism on one side for the time being. But Vitalism had not been overthrown; it had only been purified, and hence it is that we lay stress on our statement that the old Vitalism died literally by a process of self-extermination."

The reaction alluded to was started by Lotze and Claude Bernard. The article of the former on "Life and Life-Force" in the first volume of Wagner's "Dictionary of Physiology," published in 1842, is regarded by Driesch as "the most solid of all attacks upon Vitalism." Claude Bernard, an acute critic, was really a Vitalist himself, as clearly appears from some of his statements; but his criticism, with that of Lotze, led up to materialistic doctrines often associated with the name of Darwin, but more properly belonging to the school known as Darwinian. As we proceed in our study we shall rapidly discover that Darwin and "Darwinism" so-called are sometimes—one might almost say frequently—very different things. Driesch considers that there were four circumstances which "fundamentally

teach that there is in man, distinct from the rational sentient soul, a vital principle, the source of vegetative life. This theory used to be styled Vitalism, though that term now includes *Animism* and all doctrines which maintain the reality of a *vital principle* superior to the chemical and physical properties of matter. Others make the rational soul numerically different from the common subject of sentient and vegetative activities. In opposition to these various hypotheses the Peripatetic doctrine, sometimes called Animism, holds that *in man there is but one actuating principle, the rational soul,* which is, however, capable of exerting the inferior modes of energy exhibited in sensuous and vegetative life. In this view the plant possesses merely a 'vegetative soul,' the brute a 'sentient soul,' containing virtually, however, the faculties of the vegetative principle. It is hardly necessary to remind the reader here that the proof of a spiritual principle in man is independent of all theories regarding the nature of vegetative 'souls.'"

[1] "History of Vitalism," pp. 123–5.

determined the character of all thought about nature, and indeed on many other problems, in the second half of the nineteenth century. First of all, the rise of a materialistic metaphysic in express opposition to the idealistic identity-philosophy. Then Darwinism, which explained how by throwing stones one could build houses of a typical style. Thirdly, the discovery of the law of the Conservation of Energy by Robert Mayer—a proposition which, in spite of the poverty of its content, enraptured all the natural sciences. Lastly, and of particular importance in reference to Biology, the discovery and systematic investigation of the delicate structures of living beings with the help of improved optical instruments."[1]

This fact stands out, however we may account for it, that for most of the second half of the last century, Materialism (in the sense opposed to Vitalism) was dominant in all the scientific schools. "Things were not pleasant," says Driesch,[2] "for the few who, when materialism was at its zenith, guarded the tradition of the old, i.e. of the vitalistic biology. People would have preferred to have locked them up in mad-houses, had not 'senility' 'excused' them up to a certain point."

The above sentence might be looked upon, by those unacquainted with the scientific literature of the period in question, as being an exaggeration. That such is not the case, those who lived during the period and followed its discussions are very well aware.

That a change has come over the face of the scientific world no one now doubts. To-day it is the anti-vitalists, to whom, were it not ignoble to do so, the heartless taunt of senility which found a place on their lips might be retorted ; it is they who are in the minority. The arguments and facts which have led to this change of opinion will have to be discussed in some detail : but before we attack them it will be well to cite some quotations showing the attitude of mind of scientific teachers on both sides of the controversy.

Huxley :[3] "The whole world, living and not-living, is

[1] "History of Vitalism," pp. 137–8. [2] *Ibid.*, p. 149.
[3] "Belfast Address," 1874.

the result of the mutual interaction, according to definite laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed." Again :[1] "That the living body is a mechanism . . . is now the expressed or implied fundamental proposition of the whole of scientific physiology."[2]

Burdon-Sanderson in 1889 said that "for the future the word 'vital,' as distinctive of physiological processes, might be abandoned altogether."

Without piling up further references on this side we may look at one more statement by Le Dantec, from whom quotation has already been made.[3] Alluding to the possible fabrication of a living cell in the laboratory, he says : "When the effective synthesis is obtained, it will have no surprises in it—and it will be utterly useless. With the new knowledge acquired by science, the enlightened mind no longer needs to see the fabrication of protoplasm in order to be convinced of the absence of all essential difference and all absolute discontinuity between living and not-living matter."

In the following pages many quotations from exponents of the other side will find a place : it will not be necessary, therefore, to quote here more than one or two as a set-off to those given above.

Von Bunge in 1886 declared that "the mechanical theories of the present are urging us surely onwards to the vitalistic theory of the future." This utterance was made when Materialism was at its zenith. It was beginning to decline when the next statement to be quoted appeared. This was

[1] "Collected Essays," i., 199.

[2] To this may be added the following note from the author's "What is Life ?" p. 6 : "There is a curious difference between the phrasing of the first and second editions of this article which very clearly shows how definite the late professor's views were on this point, and how rigidly he excluded any such thing as a vital force from his philosophy. In the first edition he wrote 'our volition counts for something as a condition of the course of events.' But, in a later edition, fearing evidently lest he might have seemed to have bowed down in the House of Rimmon, he altered this so that it reads 'or, to speak more accurately, the physical state of which our volition is the expression.' And here he shows himself to have been a whole-hearted adherent of the most rigidly mechanical school."

[3] *Op. cit.*, p. 250.

by Haldane:[1] "In a living organism a specific influence is at work, which so controls all the movements of the body and of the material entering or leaving it, that the structure peculiar to the organism is developed and maintained." And again: "To any physiologist who candidly reviews the progress of the last fifty years it must be perfectly evident that, so far from having advanced towards a physico-chemical explanation of life, we are in appearance very much farther from one than we were fifty years ago."

Wilson, not merely the leading American authority in his own special field, but perhaps the most eminent living cytologist in the world, has said:[2] "The study of the cell has on the whole seemed to widen rather than to narrow the enormous gap that separates even the lowest forms of life from the inorganic world."

In this connection it is somewhat remarkable that up to quite recently—some might even claim up to now—the leading supporters of vitalism have been met with rather in America and in Germany than in England. No doubt this is due to the fact that in the last-named country the interests of biologists, under the Darwinian stimulus, have largely been turned in the direction of what Driesch calls "the phantasy christened Phylogeny."[3] In the other countries mentioned matters relating to the life-histories of living things, ontogenetical problems, to use the technical term, have been more to the front.

If we are to deal with the subject without undue periphrase we must give some name to the "something" which we have been discussing. I fully admit that "vital principle" is not an ideal term, though it is better than "vital force," since it avoids the technical difficulties associated with the term "force." Inadequate as it is, I mean to use this term throughout, since it is understandable and at least as good as the substitutes which have been proposed. One author, for example,[4] prefers "biotic

[1] "Nineteenth Century," 1898, ii., p. 400. The writer is a distinguished teacher of Physiology at Oxford.

[2] "The Cell in Development and Inheritance," Macmillan, ed. ii., 1900, p. 434.

[3] "History of Vitalism," p. 140.

[4] Moore, "Recent Advances in Physiology and Bio-Chemistry," Arnold, 1906, p. 4.

energy " to " vital force," though it is not easy to see how Greek makes belief in such a something easier than Latin. Williams talks of " genetic energy " ; Cope of " a growth or bathmic-force " ; Henslow speaks of it as a " property of self-adaption," and Eimer as one of " direction." Driesch goes back to Aristotle and calls it " entelechy," no doubt an excellent term, though puzzling to the ordinary reader. Let us adhere to the term " vital principle," and let us be quite clear what we mean by that term. We mean something not within the range of mechanics, of chemistry or of physics, something which makes living substance different from not-living. Is there such a something ? Is the use of such a term as vital principle a mere word-explanation, not connected with any underlying facts ? Such are the questions which we have to consider, and in doing so let us remember what an answer in the negative implies. It implies, as I have said elsewhere,[1] " that all the phenomena exhibited by living bodies, including the poetry of Shakespeare and Wordsworth, the profound reasonings of Aristotle or Sir Isaac Newton, the generous instincts of a Fry or a Howard, these and all other minor manifestations of life are explicable and may, therefore, some day be explained in terms of chemical equations and physical experiments. It seems a hard saying, and one thing is clear, namely, that if this is true, there is an end to biology as a science, an end also to psychology, an end to all branches of science dealing with living things, since all these must resolve themselves into branches of the two only sciences of chemistry and physics."

Bearing these points in mind we may now turn to a consideration of the evidence offered in favour of vitalism. And we may commence this consideration by reviewing the characteristics of the simplest living object, the single cell. We must endeavour to ascertain whether the processes which we observe in it are explicable on purely chemico-physical lines, and we can then proceed to a wider study of the field of life and its manifestations.

[1] " What is Life ? " p. 8.

CHAPTER XXVI

THE CELL—ITS CHARACTERISTICS

SINCE a cell or a congeries of cells constitutes all living things, it will be well to begin with a cell in our attempt to ascertain whether living things are machines or something quite different from machines. In discussing this and other biological matters my effort will be to write as simply and untechnically as possible, so as to be comprehended by the general reader. Others, if this book should secure such, must pardon the crudities which must necessarily attach themselves to this kind of exposition.[1]

A cell then is a mass of protoplasm—sometimes contained within a bag or sac, which is then called its *wall*, sometimes not. It is generally provided with a specialised portion called a *nucleus*. It may have *vacuoles* and also organs called *centrosomes* and other contents, as to which nothing more need be said. Whatever else there may be, the essential feature of the cell is its protoplasm, whether differentiated or undifferentiated. This substance, which Huxley quite correctly spoke of as the physical basis of

[1] Those who desire to pursue further studies in connection with the subject of this and the immediately succeeding chapters may be referred to the following works :—

"The Cell in Development and Inheritance," by E. B. Wilson. New York, Macmillan ; the best book on the subject, but highly technical in character. "The Science and Philosophy of the Organism," by Driesch. Gifford Lectures, 1907, 1908, Black, London. "The History and Theory of Vitalism," and "The Problem of Individuality," Macmillan, London, 1914. "Mechanism, Life, and Personality," by Haldane. London, Murray, 1913. "L'Enigma della Vita ei Nuovi Orizzonti della Biologia," by Gemelli. Firenze, Libreria Editrice Fiorentina, 1914. "What is Life?" by Windle. London, Sands & Co., 1908. On the anti-Vitalistic side the following may be read : "The Nature and Origin of Life," Le Dantec. London, Hodder & Stoughton, 1907. "Mechanism of Life," Leduc. London, Rebman, 1911. "The Evolution of Life," Bastian. London, Methuen, 1907.

life, consists of comparatively few chemical substances—carbon, hydrogen, oxygen, nitrogen, sulphur and traces of some other elements. We only know it chemically in the dead state, and there is no certainty that we can speak of it as a chemical compound with a definite molecule and formula. If it has these they must be of quite extraordinary complexity; indeed Wallace[1] said of it: "Protoplasm is so complex chemically as to defy exact analysis, being an elaborate structure of atoms built up into a molecule in which each atom must occupy its true place, like every carved stone in a Gothic cathedral." Pflüger, a very distinguished physiologist, also claims that living protoplasm is a huge molecule, undergoing constant, never-ending formation and decomposition. He further suggests that it may quite probably behave towards the ordinary chemical molecules as the sun behaves towards small meteors.

Where the cell has a wall the cell-protoplasm or cytoplasm is enclosed within it: where it has not, it exists as a naked viscid drop, visible under the microscope. In the substance of the cytoplasm is the nucleus. Like the cell this is sometimes naked, sometimes enclosed within a sac, forming a sort of bag within a bag. Within the nucleus there is a specialised form of protoplasm, arranged in a kind of skein-like thread, which is known as *chromatin*, from the property which it possesses of staining deeply with certain chemical substances. Some have looked upon this as the most important and significant substance contained in the cell and have claimed for it the function of carrying the cell's hereditary characteristics.[2] Certainly the chromatin skein becomes broken up and distributed whenever a cell divides—a process which is constantly occurring during the development of the individual from the condition of an ovum to that of a fully developed speci-

[1] "Man's Place in the Universe," London, Chapman & Hall, 1904, p. 199.

[2] Whilst these pages are passing through the press there has been published a work on the "Mechanism of Mendelian Heredity," by T. H. Morgan and other writers (London, Constable, 1915), in which it is claimed that the chromosomes are the bearers of the characters inherited on Mendelian lines, but that there are other characters which may be borne by the cytoplasm or cell-substance and not by the chromosomes. The whole question is at present quite unsettled.

men of its race, as well as during its subsequent history until death brings matters to a close.

To sum up: in a typical cell we find, firstly, an enclosing cell-wall. Within this there is a mass of viscid protoplasm, called the cytoplasm. Floating in this cytoplasm is the nucleus contained within its nuclear wall. And, finally, within the nucleus are the skeins of chromatin, together with a protoplasmic basis, like the cytoplasm of the outer part of the cell but called *linin*. Time was when the cell was regarded as a very uncomplicated structure, in fact the term "the simple cell" was one quite commonly met with in text-books; but this grossly misrepresented the facts. The result of the close and unintermitting study of cytology—the science of the cell—for the past forty or fifty years has been to show that the character of that "simple" structure is complicated beyond description. Someone has said that if we can imagine a "Dreadnought" filled with machinery of the delicacy of that found in an ordinary watch, we shall have some idea of the multiple energies contained within each of the millions of millions of cells which make up the human body and all other living things, vegetable or animal.

Whether this living thing is unicellular or multicellular—of the size of an elephant or only visible under the microscope—it presents certain characteristics not noticeable in non-living matter which must now be described. It will be convenient for our purposes to study them in the simplest possible form, namely, the Amœba—a minute water creature about one-hundredth of an inch in diameter, a single living cell of the type already described. Let us study this tiny being under the microscope and observe its peculiarities.

First of all we notice that it moves about. It pushes out a kind of promontory formed of its own substance and then pulls the rest of the cell of which it consists to join that promontory; and thus it slowly moves from place to place. The form of motion is slug-like, though it is the motion of a single cell and not of a vast congeries of cells like the slug. Another curious thing which may be noted about its motion is that it takes place against the stream if the Amœba should find itself in non-stagnant water. If whilst watching

the creature under the microscope we set up a current in the water, the Amœba will move in the opposite direction to the current: perhaps it has this habit or instinct or whatever we may choose to call it in order to permit it to maintain its position in running water and not to be washed away by it. Apart from this motion from place to place, the Amœba exhibits another form of motion: for if we examine it carefully we shall find that the protoplasm in its interior is in a constant state of flow. As an able writer has said, the granules in the protoplasm "stream constantly forwards along the central axis of each process as it forms, and backwards within the clear layer all round, like a fountain playing in a bell-jar."[1]

It may be remembered that the power of motion has been regarded as the salient feature of living things and taken as the best definition of life.[2]

In the second place we may notice that we can make the Amœba move: if we touch it with the point of a fine needle, for example, it will contract itself and draw in any processes which it may have thrown out. This function is called "irritability" and it is one of the most remarkable which living matter possesses. When this function of irritability comes into play, some of the internal energy of the Amœba is transformed from the potential to the kinetic state; this is done in "response to an action of itself inadequate to produce it and has been compared not inaptly to the discharge of a cannon, where foot-tons of energy are liberated in consequence of the pull of a few inch-grains on the trigger; or to an indefinitely small push which makes electric contact: the energy set free is that which was stored up in the charge."[1]

In the third place we can watch the Amœba feed itself.

[1] Hartog, "Protozoa," Camb. Univ. Press.

[2] See p. 272. St. Thomas Aquinas ("Summa Theologia 1a," 9, 1, art. 1) says: "Illa proprie sunt viventia quæ seipsa secundum aliquam speciem motus movent." And again ("S.T. 1a," 9, 18, art. 2c): "Ens vivum est substantia cui convenit secundum suam naturam movere seipsam." In considering these statements one must be careful to bear in mind that the term motus or motion is used in the scholastic sense and not in that of everyday usage. On this see "What is Life?" pp. 29, 30, and for a full discussion of the whole question, "La Définition Philosophique de la Vie," by Cardinal Mercier, published at Louvain in 1898.

Should it come in contact with any particle of suitable food in the water in which it lives, the Amœba slowly surrounds it and takes it into the interior of its single-celled body. There we are only conscious of the gradual disappearance of the particle of food. We cannot follow this process under the microscope, for it is of a chemical character. But we know that the food is split up into its component parts; it is transformed and all or part is assimilated so as to form part and parcel of the Amœba body and to make up for the natural wear and tear which takes place in it. Such parts of the food as are not required are cast out of the body as refuse.

In these processes two classes of constructions or reconstructions take place. There are "anabolic" processes during which energy is absorbed and by means of which more stable and less complex substances are built up into less stable and more complicated. On the other hand, there are "catabolic" processes, of a directly opposite character, in which these unstable complicated substances are broken up into stabler and simpler forms. This process is accompanied by the giving out of energy. We may compare the manufacture of an explosive to the anabolic process. Energy is stored up: the explosion is the catabolic process which leaves behind it what we may call inert chemical compounds.

The prime object of these processes is the carrying on of the life of the body; but they are accompanied, in what we think to be a wholly secondary degree, by the formation of by-products. Some of these—e.g. the bile formed by the liver—have their own proper and indeed necessary function in the animal. As to others—as for example musk in the animal which produces it—it is hard to say whether they are of any real use to the producer. They may be, but it is possible that they may be of the nature of excretions. Closely associated with these assimilatory processes are those of respiration. In a sense we may look upon the breathing of air as a form of feeding, for no living thing can get on without a proper supply of air. We cannot see the Amœba breathe; but of course it absorbs oxygen from the water around as do all other water creatures,

and no doubt also discharges its carbonic acid into the same medium.

In the fourth place, if we are fortunate, we may observe the Amœba multiply its race by division. Omitting the remarkable occurrences in connection with the chromatin which accompany this process, we may briefly say that the single cell divides into two, so that where there was previously but one Amœba there now are two. Of these it may be remarked that it is quite impossible to call one the mother and one the child or even to speak of them as belonging to two generations. There are two Amœbæ where there was only one. That is all that we can say.

In the fifth and last place the Amœba can die. Seeing that each Amœba renews its youth, so to speak, by dividing, or can do so under favourable conditions, there seems no impossibility in supposing that a given portion of protoplasm forming an Amœba might be actually immortal—using that word in its common significance.

But there is no question that we can kill an Amœba by poisoning its water, or by electrocuting it, or by depriving it of water for a sufficient period of time. Now a remarkable thing happens. Whilst the Amœba was alive it was the master, and the chemical substances with which it dealt, notably oxygen, were its servants. Now the conditions are reversed, for the servants begin to prey upon their former master until it is destroyed. "This change is associated with changes in the mechanical and optical properties of the protoplasm, which loses its viscidity and becomes opaque, having undergone a process of *de*-solution; for the water it contained is now held only mechanically in the interstices of a network, or in cavities of a honeycomb, while the solid forming the residuum has a refractive index of a little over 1·6. Therefore, it only regains its full transparency when the water is replaced by a liquid of high refractive index, such as an essential oil or phenol. A similar change may be effected by pouring white of egg into boiling water or absolute alcohol, and is attended with the same optical results."[1]

Such then are the chief characteristics of the Amœba,

[1] Hartog, *ut supra.*

and such also are the characteristics of all living things, be they vegetable or animal. We can recognise all of them in ourselves and in all other living things, with the necessary modifications and differences.

Can we recognise them in not-living matter? As to motion: certainly not-living matter has no motion of transference in itself. It must be moved by something, whether that something be the force of gravity or a kick by a boy's foot. According to physicists there is a constant motion going on inside the atom; but that form of motion, it must be remembered, must be taking place within all the atoms which make up the chemical substances of which the living tissue consists. It is quite a different kind of motion from that which is exhibited by these chemical substances under the guise of flowing protoplasm. Its motion is limited to the interior of the atom and has no external effects, nor can we by all our experiments liberate this energy, or cause it to act outside the narrow confines within which it exists. Hence we may conclude that motion distinguishes living from not-living matter.

The same statement can be made as to irritability. We know very well that we can tickle a stone all day without producing any effect upon it. We can move it of course by exerting force, but that is not the making a thing move by itself. But here we come up against an argument used by the anti-vitalistic school. Writers like Le Dantec claim that the phenomena of irritability are really referable to what he calls *tactisms*. After discussing certain movements in connection with the reproductive cells of a fern, he declares that "the *irritability* peculiar to this cell species can be thus reduced to a sum of perfectly well-defined *tactisms*," and proceeds, "after this *nothing* remains of the pretended spontaneity of movement in living bodies. An observer conversant with the results of all these experiments in tactisms *knows* that the movements he observes in living bodies through the microscope are due to the colloid and chemical reactions of the mobile beings and the medium."[1] Any person who takes the trouble to read Le Dantec's book and to consider the evidence which he brings forward for

[1] *Op. cit.*, p. 163. Italics as in original.

this very sweeping statement will, we think, be inclined to agree with us that forcefulness of assertion does duty for cogency of evidence.

Let us take one example of a tactism and see how it works out. The assertion is that there is no such thing as spontaneity of movement in living things. It is all due to a chemical reaction transmuted into a tactism. It is a chemical reaction then which causes a mouse to fly from a cat: it is a chemical reaction which causes me to desire to sit down by the side of one person and to shun another like the pestilence. Once stated in this way, common sense teaches us that the theory is untenable; but we can go a little further. It is one of the essential features of a chemical operation that it must always act in the same way: add the same reagents and you get the same result: repetition and age cannot alter this fact. If it is a chemical reaction which causes a bird or a wild animal to fly from the face of man, that reaction must occur at the very first time when the reagents are brought into contact; yet we know very well that this is not so. For example, there is the well-authenticated case of the walruses in the South Sea Islands,[1] visited by German explorers in 1799. "On the arrival of the expedition, the animals were perfectly tame and fearless; but advantage was taken of this to hunt them down and secure their flesh as meat for the European visitors, and by the end of the winter the animals were already difficult to approach. The following winter, when another exploring party arrived in those parts, the walrus fled whenever it perceived a human form in the distance; it had grown to recognise man as its enemy, and took refuge in instinctive flight." This and a number of similar cases which might be cited dispose altogether of the tactisms theory, which, it may be added, never really established itself even amongst materialistic writers.

As regards assimilation, the question of the formation of crystals has sometimes been urged as a form of feeding and growth; and there is this superficial resemblance, that undoubtedly a small crystal can take up fresh supplies of

[1] See Chatterton Hill, "Heredity and Selection in Sociology." Black, London, 1907, p. 74.

the chemical substance of which it is composed and in this manner add to its size.

But, to begin with, the crystal can only take up a chemical substance identical with itself and can only take up that substance unchanged and add it to itself superficially and not interstitially. The Amœba and all other living things take up many different substances as food. It may be said that the living thing practically never adds such substances unchanged to its own body, but breaks them up and, having transformed them into something assimilable, adds them interstitially and not superficially to its substance. There are other arguments; but enough has been said to show that the crystallisation parallel completely breaks down when carefully examined.

The not-living substance cannot reproduce itself, nor can it in any proper sense of the word be said to die. It might be urged that iron rusts when exposed to damp, and that in that case the oxygen became its master as it did that of the dead Amœba. No doubt; but the difference is this. So long as it is alive the Amœba can protect itself against the oxygen and be its master. Once it has emerged from the state of ore the iron cannot, unless man, who has extracted it from its ore, protects it, it will commence at once to succumb to the action of the atmosphere. It is *never* self-protective, as the Amœba and other living things are, so long as they are alive. Is there then no difference between dead and living matter? What is it that departs from the Amœba and enables oxygen to take its revenge on its former master? It must surely be something. That something, according to the Vitalist, is the vital principle, the entelechy or what you will; and in the case of man the immortal soul, which for a time has had its dwelling in the collection of cells which we call the human body.

It does not seem that the consideration of the fundamental activities of living matter, when compared with what we know of not-living matter, affords much confirmation of the chemico-physical or "machine" character of life. The statement may be reiterated that no one doubts that at least most of the activities of living matter require chemical, physical, mechanical explanations of a secondary

character. No one doubts this. What is urged is that these explanations are not a full explanation; that there are facts left over which cannot be explained by them; that there is a something else unaccounted for by them which must be taken into consideration. The further arguments in connection with this will occupy the next chapters. Here we only add a statement from one of the most recent writers on this subject.[1] The concept of this "something"—a vital principle—is, he says, "forced upon us mainly because of the failure of mechanistic hypotheses of the organism. If our physical analysis of the behaviour of the developing embryo, or the evolving race or stock, or the activities of the organism in the midst of an ever-changing environment, of even the reactions of the functioning gland, fail, then we seem to be forced to postulate an elemental agency in nature manifesting itself in the phenomena of the organism, but not in those of inorganic nature. This argument *per ignorantiam* possesses little force to many minds: it makes little appeal to the thinker, the critic, or the general reader, but it is almost impossible to over-estimate the appeal which it makes to the investigator as his experience of the phenomena of the organism increases, and as he feels more and more the difficulty of describing in terms of the concepts of physics the activities of the living animal."

[1] Johnstone, "The Philosophy of Biology," Camb. Univ. Press, 1914, p. 318.

CHAPTER XXVII

VITALISM—I

IN the previous chapter attention was called to the fact that the processes of chemistry and physics are rigid and definite. Given a certain combination of reagents or of factors, and certain results may be looked for with perfect assurance: interfere seriously with these factors or their co-operation, and the whole process will collapse. So with a machine: it will do one thing or possibly two or three things, but it will do them only in one way; and if you so interfere with it that it cannot do its work in its own way it will not do it at all. We must bear these points in mind when we are considering the statement that living things are machines and that, if we understood them sufficiently, we could write down all their activities in chemical or physical formulæ.

Let us look at this proposition from two or three points of view, and first from that of reproduction. With certain exceptions with which we need not at present concern ourselves, multicellular living things reproduce themselves by the union of two cells of opposite sexes, which unite to form a single cell. The mouse and the elephant, and much smaller things than the mouse, originally consisted of a single cell; and these cells were very slightly different in size, and could with difficulty, if at all, have been distinguished from one another even by the most expert microscopists. How is it that out of this single cell so great a thing as an elephant emerges? And what is it which makes one cell become an elephant and another closely resembling—almost indistinguishable from—it become a mouse? These questions have long been asked by science, and to the first of them—the "how"—we can return a very com-

plete reply. To answer the question "why" is always infinitely more difficult, and in the case which we have put has so far proved to be impossible. Some day or another someone may solve the riddle of heredity, but that day has not yet arrived, nor are there any definite signs of its speedy arrival.

The future individual, then, begins as a single cell which develops into a cell-congeries consisting of millions upon millions of cells. In a very rough and generalised fashion this is how it occurs. After a series of internal convulsions primarily concerned with the chromatin, the single cell divides into two: each of these again divides so as to form four; these again, eight; then sixteen, thirty-two, and so on; in every instance the division of the cell being preluded by the internal convulsions already alluded to.

The result of this is the formation of a more or less spherical mass of cells adhering one to another. The whole thing somewhat resembles a mulberry; and for that reason the embryo at this stage, when complete, is called a "morula," that being the Latin word for the fruit named. A further series of processes leads to this solid mass becoming hollow: it then consists of a kind of bag formed of cells adhering to one another—something like a raspberry with the central and uneatable part pulled out: the embryo is now called a "blastula." We need not follow the process of development further; indeed it would be hopeless to attempt such a task here. This, however, may be pointed out—that, up to the time of which we have been speaking, the cells of which the embryo consists are all indistinguishable or almost indistinguishable from one another under the microscope. This condition of uniformity comes to an end later and the adult condition reveals to us cells of the most different character, many of them distinguishable not only from others but easily nameable as what they are, even by a comparative tyro. Thus there are skin-cells, brain-cells, liver-cells and so on; all different from one another yet all dating back to and deriving their existence from the single original microscopic cell.

Before going further let us consider how what we have just learnt bears upon the machine theory. Here we have

a huge machine—the elephant—capable of making other machines like to itself. This alone seems a very wonderful kind of machine; for, let us observe, it not only makes the "parts," which would not be so wonderful a thing, but it also "assembles" them, to use the technical term. This is a feat at present unaccomplished by any complicated machine if indeed by any machine. But, further, the machine not only makes and assembles the parts, but it actually carries on the two processes simultaneously, and finally creates vast complexity out of original simplicity. Of course it may be argued that the original simplicity is apparent, not real, and this no doubt is to some extent true. But the original cell is comparatively simple when one compares it with the adult fabric and its vast congeries of cells, each of them resembling in simplicity or complexity that from which they have all sprung.

We may look at the matter from another angle. If we could imagine a machine capable of making another machine just like itself, we should be imagining a very wonderful piece of mechanism, the like of which has never yet been made by man. A chisel is a simple enough tool, but one chisel cannot make another without the aid of man's hands and man's wits. If the cell only went on making other cells like itself, as the Amœba does, it would be wonderful enough, and far enough removed from anything that chemistry and physics can show us: but there might be some who would be prepared to admit that a machine which could do this kind of thing was at least conceivable. But observe what the original cell—which for the moment we will look upon as a machine—actually does. It makes whole myriads of things of different kinds, all doing different kinds of work. It makes muscle-cells, liver-cells, nerve-cells, just as our original machine might be expected to turn out from its own simplicity, locomotive engines, filtering implements of great delicacy, and wireless telegraphic machines. To most persons the machine theory, when looked at from this point of view, seems a wild phantasm of a disordered brain. I at once hasten to admit that the crude comparison of ordinary machinery hardly deals fairly with the delicate processes of chemistry which are invoked

by the materialists. I admit this at once, and only use the example because it is likely to bring the point home to those without scientific training.

Chemists and physicists, as we shall see later on, are the first to insist that they neither know of nor can imagine any processes in their branches of science which can imitate or even explain the events with which we have been dealing. It will be noted that it is usually biologists who talk in a glib way about chemistry and physics explaining these things. Yet, after all, it is to the chemists and physicists that we should go if we want information about chemistry and physics.

However, we can go a stage further. It will at any rate be granted that the machine can only do its work in its own way, and that if it is thwarted in doing it in that way it will not do it at all. It cannot be imagined that it will evade the difficulty of doing its piece of work by discovering some method never known to have been employed by any previous machine. Similarly with the chemical or physical experiment: it occurs in one way and in no other, and if it cannot occur in that way then it does not occur at all.

How does this apply to the processes we have just been dealing with? It is possible for man to interfere, and to call upon the developing cell to try to achieve its end by methods never previously attempted—of that we may feel pretty clear—by any other cell from the beginning of the history of life upon this world.

For example, there is a little fish-like creature called the Amphioxus or Lancelot, which exists in salt or brackish water near the coast in certain places. It develops from a single cell and on the lines mentioned above. Ordinarily, of course, one Amphioxus comes from one cell, the original cell. But let the experimenter take this cell and watch it until it has by four processes of division become sixteen cells. It is now well on the way to be a morula—in fact it is a small morula and if it is allowed to go on it will become a blastula and finally an Amphioxus. But the experimenter intervenes; placing the sixteen-celled individual in a test-tube with some water, he shakes it violently until the sixteen cells fall apart. The ordinary man seeing or hearing of

this experiment will undoubtedly say, "Well, there's an end of that potential Amphioxus; for if anything could kill it, that would!" What are the actual facts? Each one of these sixteen cells sets to work to divide, and in the end produces an Amphioxus: so that the net result of the experiment is that where normally only one Amphioxus would have been produced, actually sixteen, supposing everything to go well with each cell, will have come into existence.

Now here is a well-established fact which can only be accounted for in one of two ways. Either the cell is provided with machinery whereby it can adapt itself to the conditions indicated, or it has powers which no not-living machine can have—powers that is of adapting itself to absolutely new circumstances. In point of fact, these two contentions or alternatives are one. The something with which the cell is provided is the vital principle which enables it to achieve its end by means previously unknown to cells. For of the purely mechanical explanation, if indeed anyone were bold enough to put it forward in connection with this matter, this may be said. If the machine is so constructed that when broken it is capable of becoming as many machines as the pieces into which it was broken, this would be wonderful beyond all belief. But the machine must have been thus constructed without any sufficient reason, for the sort of breakage is not one which could ever have been supposed to be a likely accident. We can understand machines being made to lubricate themselves, because all machinery must be lubricated; but machines which can re-make themselves from their own parts and multiply themselves in the process are unthinkable.

Another experiment of the same category may now be described. The egg of the frog, with which almost everybody must be familiar, goes through the stages above recounted, beginning with the single cell. Every step in the course of this development has been so fully studied of late years that it is as well known as the streets of his beat are to a policeman or a postman. Experimenters have interfered with this process in all sorts of ways: for example, they have prevented the egg from developing in its ordinary

spherical manner by causing it to carry on its processes between two sheets of glass, thus giving itself plane instead of curved surfaces. They have interfered with it in a number of other ways, for an account of which readers must be referred to one of the text-books on the subject. But the unbeaten cell attains its end in spite of the experimenters, unless indeed conditions are made so hard for it that it dies. "'One is sometimes tempted to conclude,' was recently remarked by a well-known embryologist, 'that every egg is a law unto itself.' The jest perhaps embodies more of the truth than its author would seriously have maintained, expressing as it does a growing appreciation of the intricacy of cell-phenomena, the difficulty of formulating their general aspects in simple terms, and the inadequacy of some of the working hypotheses that have been our guides." These words were written by the leading authority on the cell and its development[1] in the last month of the last century, and certainly nothing has occurred in the present century to cause him to alter his opinion: rather has fresh evidence accumulated in favour of the position which he then took up.

It is hardly going beyond the facts to say that every egg is a law unto itself. Certainly every egg has the power of reaching an identical end by more than one path. This cannot, as we have seen, be achieved by any machine, nor is it known in connection with any chemical or physical experiment. It points quite clearly to a fundamental difference between living and not-living matter; and, one may say, is a complete confutation of the opinions expressed by Le Dantec and others of the materialistic school. Perhaps here it may be well to note that writers of this kind rely very much upon the behaviour of those chemical compounds which are classed under the heading of colloids. I believe it is admitted that the behaviour of these compounds is very remarkable, and that we by no means know all that there is to be known or anything like all that there is to be known about them: at the same time, chemists of the first eminence refuse to credit the idea that colloids in any way explain the phenomena with which we are now

[1] Professor Wilson of Columbia University.

concerned. A few years ago there was an important discussion on this matter at a meeting of the British Association (1913), at which great claims in this direction were made for colloids. Professor Armstrong, a chemist of the first order, laughed at this claim, and stated that "the dominant note of the communication had been the blessed word 'colloid,' and like other blessed words the term 'colloid' was used to obscure and wrap up ignorance." In the same debate the President of the Physiological Section concurred with Professor Armstrong and said that "there was a tendency to make too much of colloids in connection with life."[1]

Further, Leduc has tried to show that his chemical compounds offer some similarity to the processes of growth and development in living things. In the opinion of the present writer the toy of his youth, known as "Pharaoh's serpent," which may now be extinct—for it is a long time since he has seen one—might equally well be cited in support of the thesis in question as these beautiful but fragile and wholly lifeless objects, on the significance of which some writers who ought to have known better have so much insisted.

After this very brief account of the bearing of development on the question with which we are concerned we may turn to the developed and living individual and ask ourselves whether there are not many ways in which it also is removed by an impassable abyss from the non-living substance.

[1] These notes have been taken from the report of the address given in "The Times."

CHAPTER XXVIII

VITALISM—II

IN a work which treats of so many subjects as this does, it is of course impossible to deal in a comprehensive manner with such a vast question as that of the vitalistic controversy. All that can be done is to indicate the main outlines and to refer enquirers for further information to the books indicated in the footnote to the previous chapter. The matter, however, must not be left without touching upon another line of argument in favour of the vitalistic solution, nor without some attempt to meet the most important objection which has been brought forward against that solution.

If we scratch our hand, or, to make the matter more obvious, if we even make a deep wound in it, what happens? There is more or less bleeding in accordance with the character and depth of the wound. By degrees this ceases and if no poison has entered the wound, it gradually heals up with or without a scar. Let us pause for a moment to consider whether we can recollect any similar occurrences in connection with non-living matter. If by some unfortunate accident we knock a small hole in a gas or water pipe, it will not fill itself up, even if we stop the flow of water or of gas. There is no process of regeneration in connection with the wounds, if we may so call them, of not-living substances. It is claimed that the living body is a form of machine capable of mending such lesions. To most people such use of the word machine is unnatural, but let us go a step further.

There are animals, even vertebrate animals, which possess much higher capabilities of regeneration than we or most

vertebrates do. It is wonderful enough that a badly broken bone should be capable of re-knitting its fragments together so that in the end the limb may be as sound and strong as ever it was. But we cannot grow again a limb which has been amputated. The salamander, a vertebrate animal, can; and, what is more, can repeat the process apparently as often as it may be required to do so. It is an interesting fact that these experiments on regeneration were first conducted by two Catholic ecclesiastics. Those on the hydra, an invertebrate creature, of which more shortly, were made by the Abbé Trembley. They were the first experiments in this fruitful field. Spallanzani, of whom we shall hear again in connection with the question of spontaneous generation, was also a Catholic priest. His were the experiments on the salamander: he proved that if the tail were cut off, a new tail would grow, containing vertebræ; and further that if the leg or even all four legs were cut off, the loss would be completely repaired after a brief interval of time. His most classical experiment is one in which he, during three summer months, six times removed all four legs and the tail from the same salamander: the undaunted creature reconstructed itself on each occasion, and as rapidly on the sixth as it had on the first. Spallanzani calculated that, during the three months over which the experiment extended, this salamander had made for itself no less than 647 new bones, not to speak of all the muscles, nerves and arteries which, with the bones in question, made up the parts which had been amputated. The same experimenter found that the salamander could regenerate even its upper and lower jaws if these were removed. Again it must be pointed out that these remarkable things happened in a vertebrate. Regeneration is wonderful enough in a boneless invertebrate, but of course far more wonderful and incomprehensible in so highly organised a creature as a vertebrate.

To the general reader the facts which have just been recorded will seem much more remarkable than those which have next to be submitted to his attention, though in reality they are not so for reasons which we shall attempt to make clear before we leave the subject. The experiment in ques-

tion was made by Wolff[1] on the eyes of the larvæ of the water-newt or triton, a common inhabitant of pools. The eyes of this creature are constructed on the same lines as our own, and they contain like ours a transparent lens, called " the crystalline lens," immediately behind the central opening or pupil. It is this lens which is removed in the operation for cataract, when it has become clouded and impervious to light. Wolff performed this operation on the triton and found that it was capable of regenerating the lens within the space of quite a few weeks. It then became a matter of the greatest interest, for reasons which will appear in a moment, to ascertain how this regeneration took place. In some cases it seemed certain that a tiny fragment of the old lens had remained, and that the new lens grew from it. But in other instances it was equally clear that this was not the case; and it was then found that the new lens had been grown from the cells forming the edge of the iris—that is of the coloured curtain which surrounds the pupil. This is a really astonishing fact.

We have spoken of the blastula stage: this is succeeded by a stage in which the cells of the embryo are grouped into three layers called epi-, meso-, and hypo-blast. This is a very important stage in specialisation, for from each of these descend certain adult structures of the body. For example, from the epiblast come the skin and the brain; from the mesoblast, muscles and bones; from the hypoblast the lining membrane of most of the alimentary canal. There are other derivatives; those mentioned are only selected as examples. Now it would be as easy for an embryologist to imagine that an eagle could emerge from the egg of a pigeon as to imagine any one of these layers or their derivatives producing an organ or a tissue normally produced by another. They and their derivatives remain racially distinct; and one explanation of cancer is that epithelial cells escape into mesoblastic tissue, and there run wild and cause the disastrous results. However, be that as it may, the crystalline lens is a derivative of the epiblast, the iris belongs to the mesoblast; so that in this process of regeneration we actually have a structure

[1] Arch. f. Entwickl.—Mech. d. Organismen, Bd. i., 1895.

normally epiblastic produced from mesoblast. That is one of the most wonderful things which has ever been presented to the scientific world in connection with this question. It is even more wonderful than the case of the salamander, wonderful though that is, for in the salamander at least epiblastic structures might grow from epiblastic and mesoblastic from mesoblastic ; but such was not the case with the triton's eye.

Now let us crudely translate this into the case of the machine. Here we shall have to imagine a locomotive engine, which has lost one of its wheels, growing another from its own body and, if we are to extend the parallel to the case of the newt, actually growing a steel wheel from the glass of which one of its gauges was made. It is clear that these processes are wholly dissimilar to any processes we are acquainted with in the case of not-living matter or in the case of machines : still it is claimed that the living body is a special kind of machine capable of these regenerative processes.

To my mind Wolff's experiment appears to be quite conclusive. Here is an animal reconstructing its lens along lines never before known to be traversed—one may safely say never traversed. As in the case of the experiment on the developing egg of the frog, here is a force which gains its end by treading a path never before trodden. Is it really possible for anyone to assert that all this is explicable in terms of the rigid and unvarying laws of chemistry and physics ?

There is one thing which no vertebrate animal can do in the way of regeneration : no vertebrate animal, having been cut into two portions, can reconstruct each of those portions into a complete new individual. This operation is a mere commonplace of life amongst invertebrates, as was first shown by the Abbé Trembley in the case of the water-hydra. The common worm is another example ; and a parasitic worm, called Planaria, will make as many new planaria as were the fragments into which the original creature was chopped up. In the language of machinery the steam engine, which has been divided into fore and aft portions by some terrible accident, actually reconstructs

itself into two new and perfect engines in place of one. If such things could happen to engines, accidents of the kind would be less unpopular with the directors than they are now!

We can go a stage further in this matter of experiment; and, having given the details, we shall then be in a position to consider what all this means. The Ascidians are sea-creatures high up in the invertebrate division—in fact zoologists place them quite near to vertebrates. We need not trouble about these phylogenetic problems: it will be sufficient to note that all zoologists would allow the Ascidian to be a highly organised invertebrate. Amongst the Ascidians there is a little creature about an inch in length, called *Clavellina lepadiformis*, which has a body consisting of three portions. The foremost of these is an extraordinarily large branchial arrangement or gill-basket through which water passes: behind this are the other two portions, body and intestine-sac. Now if we cut the branchial portion off a Clavellina, both the fragments may regenerate themselves into complete forms, just as in the instances which were recounted above. But a more remarkable thing may happen: the piece of branchial basket may undergo a complete reduction of form; lose all appearance of organisation; become a minute sphere and then, after apparently resting for a few days, transform itself into a small but complete Ascidian. Further, we can cut off the branchial apparatus and having done so we can subdivide that apparatus into two parts of any shape we choose. Each of those portions will go through the process just described, and after its period of rest, will reconstruct itself into a small complete Ascidian. The branchial part of Clavellina then forms what Driesch calls by the cumbrous name of "a harmonious-equipotential system."[1]

He applies this term to "any ontogenetic totality which consists of cells with equal prospective potency, i.e. with an equal possible fate." For example, the blastula of the sea-urchin is a hollow sphere consisting of perhaps one thousand

[1] See his works as indicated in the footnote to a previous chapter on p. 280. For what follows see "The Problem of Individuality," pp. 12 *seq.*

cells. Cut this up with a fine pair of scissors in any direction you choose, each part so divided off, provided that it is not less than one-quarter of the whole, will develop into a complete larva of small size. The blastula before its subdivision is an example of what he calls a "harmonious-equipotential system." So then is the branchial apparatus of Clavellina; indeed Driesch claims that it is the "very type" of such a system, for "every element of it is able to perform any single morphogenetic action that is required, and all the elements work together in harmony in each single case, for the cut may be made quite at random." Now after the blastula has developed into the three primitive layers we no longer have a "harmonious-equipotential system" as before, unless we look upon each layer in that light—at least this is the case in higher animals. So Driesch asks the question: "What makes the equipotential system unequal with regard to the actual fate of its parts? What transforms equal potentialities into equal actualities? In other words: the localisation of the various singularities of morphogenesis is the problem. Whence does this localisation come?"

It does not come from without. That we know: for we know that external agencies such as light and gravity have no effect on ontogenesis. It is not due to chemical processes within the organism. "From chemical disintegration or from unmixing there can only arise equilibria or, so to say, geometrical arrangement. But an organism is not a geometrical arrangement or a complex of such arrangements. And, further, there are many organs in an organism which have very different specific forms, though they have the same chemical composition—as, for example, the bones of vertebrates. For all this a purely chemical theory of ontogeny—which otherwise might be compatible with equipotentiality—cannot account."

Failing these, can any form of the machine theory explain the circumstances? The machine might be defined as "a given specific combination of specific chemical and physical agents." Is ontogeny the result of the "interaction" of such agents? I will continue the argument in Driesch's words. "If normal undisturbed embryogenesis alone would

result in the formation of a complete embryo, if in other words, all the experiments carried out with early embryonic stages would result in the production of fragments of organisation, then we should feel obliged to accept the theory of machine-like preformation. But this is not the case. On the contrary, the ontogenetic systems are 'harmonious-equipotential.' Take whatever portion of them you like, quite at random, and yet there will be a completeness of final organisation." The embryonic "machine," then, that is supposed to be present in its completeness in one part of the system, is also in another such part, and in yet other such parts, and equally well in parts of different size, overlapping one another.

Let the reader draw on a scrap of paper a rectangular figure of moderate size. Let him then draw upon this a series of other rectangular figures, all included within the original rectangle and overlapping one another. Now the outer rectangle is a harmonious-equipotential system in its normal undisturbed state. It *might* contain some very complicated form of "machine" as the foundation of development. But all the other rectangles which have been described within it—and their number might be very great—provided that each is not too small, also contain the power of developing a complete individual and must contain the same "machine." But it is surely absurd to suppose that any fragment of the original "harmonious-equipotential system" can, nay must, contain the same "machine" as the whole. "We know that *any* part of the system, contingent as to its size and as to its position in the original system, can give rise to a complete being. *Every* cell of the original system can play *every* single rôle in morphogenesis; *which* rôle it will play is merely 'a function of its position.' In face of these facts the machine theory becomes an absurdity. These facts contradict the concept of a machine; for a machine is a specific arrangement of parts, and it does not remain what it was if you remove any portion from it. Now the machine theory was the *only* possible form of a mechanistic theory that might *a priori* seem to be applicable to the phenomena of morphogenesis. To dismiss the machine theory, therefore, is the same as to

give up the attempt of a mechanical theory of these phenomena altogether. Or, in other words, the analytical discussion of the differentiation of harmonious-equipotential systems entitles us to establish the doctrine of the *autonomy of life*, i.e. the doctrine of so-called vitalism, at least in a limited field: there is some agent at work in morphogenesis which is not of the type of physico-chemical agents."

The arguments which have been put forward in this and the preceding chapter with others for which readers must be referred to larger treatises on the subject, have convinced many—it would perhaps now scarcely be incorrect to say most—biologists that something exists in living matter which does not exist in not-living matter, which something makes it living matter and is altogether out of the category of chemical and physical phenomena. It is this "something" which we speak of as the vital principle.

Note to Chapter XXVIII.—I have endeavoured to put Driesch's vastly important but certainly complicated argument, as to the "harmonious-equipotential system," as clearly as I can in his own words and in my paraphrase. For the sake of making it more obvious to those unfamiliar with philosophical discussions it may also be put in this much cruder way:

(1) A certain collection of cells is normally destined for a certain termination—it is to do a certain piece of work.

(2) But we may divide this collection of cells up into half a dozen pieces, each of which and all of which will do that piece of work, so that instead of one piece of work there will be six pieces of work.

(3) Further, the method of sub-division is quite arbitrary, that is, we may cut the primary collection up in any sort of way provided we do not make any piece too small—the same result will follow.

(4) It is just conceivable that there might be a machine in the original collection to effect its purpose.

(5) But we should have to postulate subsidiary machines all over the collection and even over-lapping machines to explain what occurs.

(6) This is an inconceivable condition of affairs.

CHAPTER XXIX

VITALISM—III

THE chief objection which is brought against the vitalistic explanation—most certainly the objection which presents the greatest difficulties—is that which is connected with what is called the Law of the Conservation of Energy: a matter which must be discussed before we turn to the question of the origin of life.

Energy is a capacity for doing work possessed by bodies under certain circumstances. For example, the weight of a clock can do work, because it is drawn towards the earth by the force of gravitation, though we do not know exactly what that is. As it is so drawn, it overcomes the friction between the works of the clock, and the clock "goes." Or again, if a bullet be fired at a plank it exhibits energy, though it loses its motion, for it penetrates more or less deeply into the wood. The former kind of energy is called potential, the latter kinetic. One may be *transmuted* into the other.

Moreover, there are many manifestations of energy, some of which, by those unfamiliar with physical treatises, might not be thought to belong to such a category. Light, heat, sound, rotation, vibration, elastic strain, gravitative separation, electric currents and chemical affinity are enumerated by Sir Oliver Lodge.[1] But whatever may be the differentiations of energy the total amount of energy is constant throughout. For example, if one takes a stone into one's hand and throws it up into the air, a certain amount of kinetic energy is transmitted to the stone and exercised by it in its upward flight. At the summit of its flight there is an instant, very brief of course, during which it is neither

[1] "Life and Matter," p. 21.

rising nor falling, but is actually at rest. For this brief instant its energy is potential ; but it becomes kinetic again as the stone commences to fall. In time it reaches the earth, and as it lies there inert one might suppose that it had lost all its energy. Kinetic energy it certainly has not, for it is at rest. Nor has it potential energy, for it lies, by our hypothesis, on a flat surface of earth. Yet the impact of the stone with the earth has caused a certain amount of heat to be produced. It would be difficult if not impossible to measure the amount of the heat. No doubt, but everyone knows that if we hammer a piece of iron on an anvil it will become hot as the result of the blows which we give. As the result of the blow which the stone gave to the earth in falling upon it, heat also is produced ; the energy thus exhibited is exactly equal to the kinetic energy which the stone had in falling, and both of them are each equal to the potential energy which it had at the moment of the zenith of its flight. Not to multiply examples, "in every case, without exception, it is found that the sum-total of all the energy within any given boundary, through which energy is not allowed to pass, remains constant, although the energy within the boundary may be transformed into any of the many forms in which it is capable of existing."[1] And "it follows that if the boundary considered includes the universe, the principle of the conservation of energy amounts to a statement that the sum-total of the energy of the universe is a fixed unalterable quantity." That no doubt is so ; but in connection with the statement just quoted we must not forget that the amount of *available* energy is constantly if slowly decreasing. We have just seen that when the stone fell upon the ground, its kinetic energy was transmuted into another form, namely, heat. In a very short time the exceedingly small amount of heat produced will have diffused itself amongst surrounding objects, so as to become what we call "lost." And lost it is to this extent, that it can no more be utilised to do work. When a body is much hotter than the bodies which surround it, it can be utilised to do work, but generally diffused heat cannot be used for this purpose.

[1] Watson, "A Text-book of Physics," London, Longmans, 1911, p. 87.

Now in every transformation of energy some of the energy is converted into heat. For example, in the case of the clock the friction between parts of the escapement and between the wheels, etc., causes a certain amount of heat and so with other operations which will occur to anyone. Thus "since in every transformation of energy from one form to another some of the energy becomes converted into uniformly diffused heat, the total quantity of *available* energy of the universe is continually diminishing. This continual degradation of energy, which accompanies every phenomenon with which we are acquainted, leads us to two conclusions: Firstly, since the quantity of unavailable energy is continually increasing, there must have been a time when none of the energy of the universe was unavailable, and before which no phenomenon, such as we are acquainted with, can have occurred, for every such phenomenon necessarily involves a degradation of energy. Secondly, there must necessarily arrive a time when all the energy will be unavailable, the whole universe having become a uniformly hot, inert mass."[1] I admit that what has been stated in the immediate context is somewhat in the nature of a digression, but it is of such importance in connection with other portions of this book that it may be allowed to stand. We must, however, return from it to the consideration of the difficulties which this Law causes in the acceptance of a vitalistic explanation of the riddle of life.

We have seen that energy appears to be indestructible: some scientific men have even adopted the metaphysical idea that it is a real thing or substance. Thus[2] P. G. Tait, one of the greatest physicists of the time, wrote: "The only other known thing in the physical universe, which is conserved in the same sense as matter is conserved, is energy. Hence we naturally consider energy as the other objective reality in the physical universe." If we are to accept the Law of the Conservation of Energy as rigidly and completely final, we must admit that a vitalistic explanation of life does infringe that Law or appears to infringe it. If vital

[1] Watson, *ut supra*, p. 88.
[2] In the 9th ed. of the "Encyclopædia Britannica," *sub voce* "Mechanics."

or psychical influences can modify or direct the course of physical processes, then such influences, it is argued, must either increase or diminish the amount of physical energy in the universe, and in so doing must violate the law with which we are dealing. It has been urged by some that the amount of the power which frees the energy under the vitalistic theory is so small as to be negligible. That it is small is clear—indeed it has been compared to the spark which sets free enormous energies in the explosion of a cannon. "As far as we can judge," writes Balfour Stewart,[1] "life is always associated with machinery of a certain kind, in virtue of which an extremely delicate directive touch is ultimately magnified into a very considerable transmutation of energy." But this explanation is not really satisfactory for, from the standpoint of the law, it is immaterial whether it is grossly or almost unobservably transgressed, in either case it *is* transgressed. Romanes, in his earlier days, formulated the difficulty in his Rede Lecture:[2] "If mind is supposed, on no matter how small a scale, to be a cause of motion, the fundamental axiom of science is impugned. This fundamental axiom is that energy can neither be created nor destroyed—that just as motion can produce nothing but motion, so, conversely, motion can be produced by nothing but motion. Regarded, therefore, from the standpoint of physical science the theory of Spiritualism is in precisely the same case as the theory of Materialism; that is to say, if the supposed causation takes place, it can only be supposed to do so by way of miracle." The reader, for reasons which will shortly appear, will be careful to note the date of this pronouncement: but similar statements are made to-day.

Thus Dr. Haldane, a vitalist with a difference, in his recent book[3] says that vitalism "implies a definite breach in the fundamental law of conservation of energy. As already mentioned," he proceeds, "every experimental investigation has hitherto resulted in a verification of this law in the case of physiological phenomena. Any 'guid-

[1] "On the Conservation of Energy," p. 163.
[2] "Contemporary Review," 1885.
[3] "Mechanism, Life, and Personality," p. 27 *seq.*

ance' of living organisms by the vital principle would imply a creation or destruction of energy; and this would be the case even if the energy created in the living substance were again destroyed before it could escape to the outside and so become measurable. The reply that this creation or destruction of energy may be extremely small is not one which can satisfy a scientific investigator. A principle which has been verified again and again under all sorts of conditions cannot be set aside except on definite experimental evidence; and this is entirely lacking."

In considering this matter one must be careful to bear in mind what a Law of Nature is. The point has been dealt with in Chapter XIII, so that readers need only to be reminded that what is meant by the term is a seemingly orderly series of occurrences as observed in nature. Now as they have been observed by fallible human beings, there is always the possibility that the observations may have been inaccurate or incomplete. As they are repeated time after time, experiments would seem to remove at least the danger of inaccuracy. Yet we know that the emergence of new facts does lead to an abandonment of views previously held to be well—even finally—established, and to the modification of what had hitherto been taken to be completely and definitely formulated Laws of Nature.

It was for this reason that attention was directed to the date of Romanes's utterance; for the time at which it was given to the world was one when men of science thought themselves much more certain of facts than they do now. "Twenty years ago," writes Dr. McDougall,[1] "the scientific world was oppressed by the sense of the finality of its own dicta. The indestructibility of matter, the conservation of energy and of momentum, the eternal sameness of the chemical atoms, the inevitable extinction of all life on the earth by loss of heat from the solar system, the never-ending alternation of evolution and dissolution of material systems, all these had become 'axioms' whose rejection was said to be impossible for any sane mind. It was felt that little remained for science to do save the working out of equations to further decimal places. But now all that is

[1] "Body and Mind," London, Methuen, 1911, p. 216.

changed,[1] the scientific atmosphere is full of the hope of new insight, the seeming boundaries of physical knowledge have proved to be spectral creations of the scientific imagination; there is a delightful uncertainty about even so fundamental a distinction as that between matter and energy; electricity, which was a wave-movement of that collection of impossible attributes, the ether, is now said to consist of corpuscles having mass; and light itself is in a fair way to become once more a rain of particles. One even hears whispered doubts about the law of the conservation of energy."

It is then conceivable, though no doubt improbable, that the law in question may turn out to be inaccurate. It certainly may turn out to be incomplete, even if useful in its incomplete state; in support of this statement I may be allowed to quote from Sir Oliver Lodge:[2] "The term 'energy' itself, as used in a definite sense by the physicist, rather involves a modern idea and is itself a generalisation. Things as distinct from each other as light, heat, sound, rotation, vibration, elastic strain, gravitative separation, electric currents, and chemical affinity, have all to be generalised under the same heading [of the Conservation of Energy] in order to make the law true. Until 'heat' was included in the list of energies, the statement could not be made; and a short time ago it was sometimes discussed whether 'life' should or should not be included in the category of energy. I should give the answer decidedly No, but some might be inclined to say Yes; and this is sufficient as an example to show that the categories of energy are not necessarily exhausted; that new forms may be discovered; and that if new forms exist, until they are discovered, the Law of Conservation of Energy, as now stated, may in some cases be strictly untrue; just as it would be untrue, though partially and usefully true, in the theory of machines, if heat were unknown or ignored."

Mention has already been made of the fact that the mechanico-physical explanation of life emanates for the

[1] Readers are referred to the Presidential Address of Sir J. J. Thomson to the British Association, 1909.
[2] "Life and Matter," p. 21.

most part from biologists rather than from chemists and physicists: this point will be still more clearly established in a later chapter. Meanwhile it may be well to set down the following quotation from Dr. McDougall's work already cited. On page 252 he says: "It is worthy of note, in this connection, that the exclusive sway in the organic world of the principles of physical science is maintained in a more confident and dogmatic manner by the mechanistic biologists than by many of the leading physicists who have enunciated these principles and taught them to the biologists. It is perhaps worth while to enumerate here a few of these physicists of the highest standing who, since the establishment of the law of conservation of energy, have expressed or implied the opinion that physical science does not compel us to believe that the evolution and life-processes of organisms are capable of being completely described in mechanical terms; such are or were Sir G. Stokes, Lord Kelvin, Maxwell, P. G. Tait, Balfour Stewart, Sir W. Crookes, Sir O. Lodge, Sir J. J. Thomson, Sir J. Larmor, Prof. Poynting."[1]

There is one important point as to which a very mistaken attitude is often adopted. Opponents of the vitalistic explanation are rather inclined to take up the attitude that it is we, not they, who must prove our position. Common sense and common observation seem to go to prove that this is not so. What we see all around us and more especially in our own selves does make it clear or apparently clear that what takes place in life is of a different character altogether from what we see in not-living matter.[2] We may feel perfectly clear from what we know best ourselves from our intimate and everyday experience—namely, conscious human life—and from the processes which take place in living matter, that life or the vital principle does modify the forces, energies, and movements of matter. Is it not perfectly obvious that the war-fever, religious revivals, electoral excitements are all ideas? Yet all exercise potent influences over the energies and movements of matter in

[1] References to the writings *ad hoc* of all these authorities are given by Dr. McDougall, *loc. cit.*

[2] Here and elsewhere in this chapter I make use of passages from my book "What is Life?" without specific acknowledgement or citation of page.

the shape of human beings, not to speak of all the material activities which they control. What I maintain is that it is not sufficient for our opponents to say, "The Law of the Conservation of Energy, which we believe to be complete and final, contravenes your conclusions." The reply is that if we can show, as we believe we can show from other evidence, that in no kind of way can the facts of life be explained on purely chemico-physical lines, then, *if* the Law in question contravenes our explanation, that Law must be, so far at any rate, incomplete or perhaps imperfectly understood. The *onus probandi*, as Dr. McDougall points out, lies with the mechanist, not with the vitalist.

Whilst this is the case, it may be added that various efforts have been made to explain the vitalistic theory in terms of the Law in question. None of these are wholly satisfying, though all of them show angles of the question approachable perhaps as part of a final explanation. For example, we are bound to recognise that in all material activities there are two things to be taken into account. First, there is the energy which is displayed; but, secondly, there is the directive power which, while it does not increase or diminish the sum of the energy brought into action, does exercise a very important influence on the sum-total of the material activity in question. The path through the ocean of a great liner is not explained merely by the many horse-powered engines which drive it through the water, but at least as much by the comparatively small amount of power exercised by the helm—a power which is propelling the vessel on its course. We must, therefore, recognise a qualitative element in all material operations, and this more especially in all operations where a clear choice of alternatives is open. In the case of a ship, it is at least conceivable that the propelling force might be associated with a mechanism which would keep it on a straight course; but it is quite inconceivable that it could be associated with a machine with the power of deciding in an emergency whether the ship was to be steered to port or to starboard. In the same way it is inconceivable that a machine should be able to decide how to regenerate a lost part of the body, such as the crystalline lens of the triton. In fact, it is not possible

to explain mechanism, if we try to do so through mechanical conceptions alone. We must recognise a dualism, though this is precisely what the monistic school so much objects to, as we shall later on have occasion to remark.

It is quite clear[1] that an agent may modify the direction of a force or moving particle without altering the quantity of its energy or adding to the work done. That is to say, it is possible to bring forward an example of a purely qualitative influence: for a power acting at right angles to the motion of a body can alter the direction of that body without increasing or diminishing the intensity of the motion. The earth revolves around the sun in its elliptic because the force of gravity holds it in that course. Suppose the sun were suddenly to disappear. Its attraction at an end, the earth would rush away at a tangent. The energy which it displays would not be altered in any way, but the direction would be wholly changed.

It may be asked whether one can in any way show that the Will or the Vital Power does act at right angles to the forces of any material energy of the organism. That, however, is an objection or an enquiry which we may rightly consider to be unfair. All that we can be asked to do is to show that there is a method by which an agent *can* modify the action of physical energies without altering their quantity.

In the remarks which have just been made we have only been dealing with the modification of a "force in being"; how about the initiation of the force or the initiation of the change of energetic direction? The pressure of the button which completes an electric circuit may produce prodigious effects, altogether out of proportion to the power exerted in the preliminary pressure, but power there must be.[2]

"It is in meeting this difficulty," says Fr. Maher,[3] "that

[1] I again quote from "What is Life?"

[2] Here we may call to mind Kant's dictum ("Metaphysiche Anfangsgrunde der Naturwissenschaft," ed. Hartenstein, Vol IV, m. s. 440) that "if we seek the cause of any change of matter whatever in life, we shall have to seek it at once in another substance, distinct from matter, although bound up with it."

[3] "Life and the Conservation of Energy in the Lower Animals."

the Scholastic conception of the relation of Soul and Body in the theory of Matter and Form is most helpful.[1] In that theory the vital principle is the 'form' or determining principle of the living being. Coalescing with the material or passive factor, it constitutes the living being. It gives it its specific nature, it unifies the material elements into one individual. It makes them, it constitutes them, it holds them a living being of a certain kind. Biology teaches us that the living organism is a mass of chemical compounds, many in very complex and unstable equilibrium. They are, many of them, tending of themselves to dissolution into simpler and more stable substances, and when life ceases the process of disintegration sets in with great rapidity. The function, then, of this active informing principle is of a unifying, conserving, restraining character, holding back and sustaining the potential energies of the organism in their unstable conditions. In this view of the relation of the vital principle to the material elements of the organism, it is obvious that the transformation of the potential energy of the organism may be effected without any form of positive pressure, however small. It will suffice simply to 'let go,' to cease to hold back, and the energies thereby liberated will tend of themselves to issue from their unstable conditions. Conceive a sack of potatoes or a bladder of gas or water. Suppose that sack or bladder endowed with the power of giving way in particular places. The contents will at once issue forth into outer space by the force of gravitation or of their own mutual repulsions. Somewhat in a similar way the 'Soul,' 'Vital Principle,' or 'Form' is holding and preserving the material elements of the organism, not in a particular space, but in certain states and conditions of unstable equilibrium."

Such considerations as the above are helpful in dealing with the difficulty which has been under discussion in this chapter. No one will claim that the last or even the penultimate word has been said upon this subject. It, however, once for all may be borne in mind that the *onus probandi* lies with the materialists, and that they have singularly failed to make good their position. For a time they seemed

[1] See Chapter IX for the discussion of this question.

to prevail ; but the tide has turned and the weight of opinion is once more on the side of the vitalists. It is hard to see how it could be otherwise ; hard to understand how any person capable of taking and endeavouring to take a really wide and complete outlook on the world of life and its operations could imagine that all these innumerable, often quite unaccountable, always widely varying operations could possibly be explained in terms of a mathematical or a chemical formula. That is what it comes to if materialism is true ; and when thus stated the whole thing becomes a *reductio ad absurdum*. If this be so, the difficulty with which we have been dealing falls with the other solution.

CHAPTER XXX

THE ORIGIN OF LIFE

AS already mentioned, in his work on Darwinism,[1] the late Alfred Russel Wallace points out that there are three stages in the development of the organic world when some new cause or power must necessarily have come into action. "The first stage is the change from inorganic to organic, when the earliest vegetable cell, or the living protoplasm out of which it arose, first appeared. This is often imputed to a mere increase of complexity of chemical compounds; but increase of complexity, with consequent instability, even if we admit that it may have produced protoplasm as a chemical compound, could certainly not have produced *living* protoplasm—protoplasm which has the power of growth and of reproduction, and of that continuous process of development which has resulted in the marvellous variety and complex organisation of the whole vegetable kingdom. There is in all this something quite beyond and apart from chemical changes, however complex; and it has been well said that the first vegetable cell was a new thing in the world, possessing altogether new powers—that of attracting and fixing carbon from the carbon-dioxide of the atmosphere, that of indefinite reproduction, and, still more marvellous, the power of variation and of reproducing those variations till endless complications of structure and varieties of form have been the result. Here, then, we have indications of a new power at work, which we may term *vitality*, since it gives to certain forms of matter all those characters and properties which constitute Life."

We shall in due course return to two other stages alluded to by Wallace; but our present task is to attack the ques-

[1] Macmillan, London, 1889, p. 474.

tion as to whence this principle of vitality came and how it originated on the earth. It cannot always have been here. There was a period, as we have learnt already, when the heat of this globe was such that nothing living, as we understand the term, could have survived upon it for a single instant. It is, therefore, clear either that life must have been imported into this planet or it must have originated there.

It has actually been suggested that the germs of life may have been brought to this earth from some other planet on a meteorite. This theory seems quite untenable, having regard to the intense heat which is engendered in a meteor in its rapid passage through our atmosphere—a heat which, one would imagine, would certainly kill any germ of life which it might possibly bear with it. But from the point of view of this book it does not matter in the least whether the theory is true or not. What we want to get at is the origin of life ; and to tell us that it was brought from another planet is no answer to the question ; it only pushes the origin a little further off. If I ask the origin of some strange implement which is shown me in a museum, my curiosity is in no way satisfied if I am told that it was brought to this country by a ship.

There are two ways only in which the origin of life can be explained : it originated spontaneously, or it was created by God.

It is on this account that materialists have made such a vigorous attempt to prove the truth of spontaneous generation, and to assume its truth where it cannot be proved. Weismann makes this quite clear when he states " Spontaneous generation, in spite of all vain efforts to demonstrate it, remains for me a logical necessity."[1]

[1] " Essays," Poulton's Trans., p. 34. Perhaps the present writer may be permitted to quote, in a foot-note, his own comment on this statement, published in " Facts and Theories," C.T.S., London, 1912, p. 86 : " A logical necessity presupposes some sort of syllogistic treatment. Weismann's major premise is perfectly clear : ' There is no such thing as a Creator.' His minor term is, ' So life was not created ' : and his conclusion, which follows, it is claimed, from the premises, is ' therefore spontaneous generation takes place.' Many a false conclusion has followed from false premises. But what is to be said of the arguments of a man of science who is capable of putting forward, in effect, a syllogism of this kind where the major premise begs the whole question at issue ? "

At the very beginning of this discussion it will be well for us to bear in mind that no religious dogma is involved in this question of Spontaneous Generation, though materialistic writers imagine that there is. To judge by their writings, it would be enough to produce the tiniest fragment of living protoplasm in a test-tube to knock the bottom not only out of the Catholic Church but out of all revealed religion. Such a conclusion is due to the dense ignorance which prevails in the scientific world as to what the Church teaches, and as to what her most distinguished writers taught during the palmy days of the Scholastic Philosophy.[1]

Now in the days before the microscope was known everybody held that life did spontaneously generate itself : what else could they have thought? Maggots were found to originate in the carcases of animals left exposed to the air. Pools swarmed with life. Eels were said to originate in vinegar. There was then no means of detecting the real origin of these and many other manifestations of a like kind. Hence it was held that life was spontaneously generated. St. Thomas and the Scholastics held this view, but never for a moment imagined that it conflicted with their belief in the existence of a Creator. When this argument is used, the stock reply is that St. Thomas argued against Avicenna, an Arabian materialist, who upheld the doctrine of spontaneous generation. This attack is based on ignorance of the real meaning of the controversy. Both parties to it, as a matter of fact, held the doctrine of spontaneous generation. What Avicenna upheld was the doctrine of the modern materialists—that spontaneous generation took place by the powers of nature itself. St. Thomas argued that it took place no doubt, but by means of powers given to nature by the Creator for that very purpose. Supposing,

[1] It is a most remarkable fact that in Driesch's "History of Vitalism," published 1914, the author should leap from Aristotle to Van Helmont without mentioning the names of St. Thomas Aquinas or any of the Scholastics. This cannot arise from the valuelessness of their works, for no person who was acquainted with the writings of this school on the subject of life and its nature could regard them as unworthy of criticism. It arises from pure ignorance,—an ignorance only explicable on the ground of that most undeserved contempt, which so many modern writers have been taught to feel and to exhibit towards everyone whose era falls within the period of the so-called "Dark Ages."

therefore, that spontaneous generation were to be proved to demonstration to-morrow—as is possible though very improbable—our feathers would be quite unruffled. We should be simply back again where we were in the times of St. Thomas Aquinas. The chemists have had to take that backward journey in abandoning the theory of the immutability of the so-called elements; it would in no way hurt us if we had to do the same as the result of the abandonment of the theory of biogenesis. The Rev. A. B. Sharpe[1] says: "If, against all probability, life could be shown to be spontaneously generated from matter, this would merely mean that the sentient or vegetative soul[2] is a resultant from certain chemical combinations, and not, as has been supposed, the direct work of the Creator. But there is no more inherent impossibility in holding that animal life is brought into being by a certain combination of chemical substances than in the converse belief, which is incontestable, that it is brought to an end by the dissolution, natural or artificial, of that combination. If we can destroy an animal's soul, as we certainly can, there is no *a priori* reason why we should not be able to make one."

The question of Biogenesis or Abiogenesis—i.e. that of non-spontaneous or spontaneous generation—can be attacked from a purely scientific point of view, and with the feeling that whichever way it is decided our withers are unwrung.

We have seen that the facts of nature seemed, in the early days of science, to establish spontaneous generation on a secure footing. It was not until the time of Harvey, the discoverer of the circulation of the blood, that the doctrine was seriously challenged; but the first real attack, which preluded by its methods and their success the final downfall of the theory, was that made by Redi, an Italian poet and physician.[3] Redi adopted the very simple plan

[1] "The Principles of Christianity," London, Catholic Truth Society, p. 59.

[2] Which one may also speak of as the vital principle or under any other term which connotes the existence of an extra-physical agency in living matter.

[3] His results were published in a little work, "Francisci Redi Patritii Aretini Experimenta circa generationem insectorum." The edition under my hands is "Amstelodami sumptibus Andreae Frisii," M. DC. LXXI.

of putting gauze screens over meat and thus proving that, when so protected, it did not develop maggots. This hitherto held proof of spontaneous generation therefore fell to the ground. We may roughly speak of Redi's method as that of sterilisation, if by sterilisation we mean the continued exclusion from a suitable pabulum of the living organisms of decay. It was by this method in the future that all great advances in this controversy were made.

Towards the end of the eighteenth century the controversy became more active; curiously enough, the protagonists were two Catholic priests. Needham (1713–1781) supported the theory of spontaneous generation and Spallanzani (1729–1799), of whom we have already heard in connection with his experiments on the salamander in the direction of regeneration, opposed the doctrine. Moreover, to Spallanzani belongs the credit of introducing the crucial experiment on which all later work depends; for it was he who showed that if fluids, which would otherwise become putrescent and be found to be swarming with life, were boiled for a sufficiently long time and kept thereafter in hermetically sealed vessels, no putrefaction took place and no life was developed. Again the controversy went to sleep until in 1858 Pouchet asserted that he had seen life develop in a sterilised medium which had been exposed to what he believed to be pure air. The discussion which this assertion provoked led the French Academy in 1860 to offer a prize to the person who could solve the riddle.

As we now all know, the answer, and that a most conclusive one, was given by Pasteur, who worked on the lines originated by Redi and perfected by Spallanzani. He showed quite conclusively that the cause of putrefaction and the appearance of living organisms in suitable pabula was not spontaneous generation but contamination by microscopic organisms, of which the air is full. Redi had commenced the discovery by showing that gross causes, such as blowflies, when excluded from the pabulum, excluded the possibility of the formation of maggots. Spallanzani went a good deal further than that, but the scientific instruments of the day were not sufficient to enable him to complete his thesis. Pasteur had the instruments and the genius and

closed the question, so far as such a question can be closed, for it must always be remembered that Pasteur did not prove that spontaneous generation does not take place: no man could prove a general negative of that kind. What he did show was that none of the evidence which had hitherto been claimed to prove the reality of spontaneous generation did actually prove it. Hence the position in which he left matters was this: Spontaneous generation *may* take place and may even be going on all around us without our knowing it; but, if so, it *is* without our knowing it, for there is not a single particle of scientific evidence in favour of such an occurrence. There are perhaps still a very few who cling to a belief in spontaneous generation, and think that it has been demonstrated; but there is no question that, as far as they can be unanimous on any point, and indeed with a unanimity more than remarkable in scientific controversies, men of science are convinced that spontaneous generation has been entirely disproved. *Securus judicat orbis terrarum:* the entire canning and bottling trade depends upon the truth of Pasteur's experiments and does not find them wanting. For a further account of Pasteur and his work the reader may be referred to any of the books and pamphlets[1]—and there are a myriad of both—which deal with the life and work of that truly great man. Meantime one may allude to three other assertions in connection with this matter—assertions which one comes across from time to time, and which had better be dealt with before we pass to the consideration of other questions.

The first of these may be thus stated: "It is true that spontaneous generation does not take place nowadays, but I feel quite sure that it did take place in bygone days." Thus Herbert Spencer[2] declared that "at a remote period in the past, when the temperature of the Earth's surface was much higher than at present, and other physical conditions were unlike those we know, inorganic matter, through successive complications, gave origin to organic matter."

[1] There is an excellent account of him by Professor McWeeney, in "Twelve Catholic Men of Science," published by the Catholic Truth Society.

[2] "Nineteenth Century," May, 1886.

We may note the delightful nebulosity of the words "through successive complications," which really beg the whole question, and pass on to the classical utterance of Huxley on the subject.[1] Huxley thought that if it were given to him "to look beyond the abyss of geologically recorded time" he might "expect to be a witness of the evolution of living protoplasm from not-living matter." And though he admitted[2] that the biogenists were victorious all along the line, he went on to claim that spontaneous generation at some time or another must have occurred because it was "a necessary corollary from Darwin's views if legitimately carried out." Misplaced faith could hardly go further. In connection with the hypothesis of life having been brought by a meteor from some planet, Reinke, the botanist, said that that idea would never have been devised had not the theory of spontaneous generation been regarded "as lost beyond all hope of recovery."[3] Spencer's and Huxley's way of recovering that which is "lost beyond all hope of recovery" was to refer it to a period before the advent of man, as to which, of course, there is not a single atom of proof or testimony. Virchow, in an address delivered at Wiesbaden in 1887, said: "Never has a living being, or even a living element—let us say a living cell—been found of which it could be predicated that it was the first of its species. Nor have any fossil remains ever been found of which it could ever be likely that they belonged to a being the first of its kind, or produced by spontaneous generation." This statement holds good to the present day.

Moreover, it may be remarked that the temperature of the globe, though possibly higher than it now is when life first appeared upon it, could not have been so very much higher, or life could neither have appeared nor continued to exist. There are no conditions, thermic, chemical or physical, which can possibly have existed on this earth at any period which cannot be perfectly reproduced on a

[1] "Critiques and Addresses," p. 239.

[2] In a letter to Charles Kingsley, published in Huxley's "Life and Letters," i., 244.

[3] As quoted by Fr. Wasmann, S.J., in "Modern Biology, etc.," p. 204.

limited scale in our laboratories; yet no one has hitherto succeeded in getting anywhere near the solution of the problem of the production of living protoplasm.

The second assertion amounts to this: "We haven't yet made living protoplasm artificially, but we are on the point of doing so." If prophesying is the most gratuitous form of foolishness in any case, it certainly has so far shown itself to be so here; the hope has been expressed time after time, yet, according to those best qualified to pronounce an opinion, we are no nearer to its realisation than we were years ago.

Sir Henry Roscoe in 1887[1] said: "It is true that there are those who profess to foresee that the day will arise when the chemist, by a succession of constructive efforts, may pass beyond albumen, and gather the elements of lifeless matter into a living structure. Whatever may be said regarding this from other standpoints, the chemist can only say that at present no such problem lies within his province. Protoplasm, with which the simplest manifestations of life are associated, is not a compound, but a structure built up of compounds. The chemist may successively synthesise any of its component molecules, but he has no more reason to look forward to the synthetic production of the structure than to imagine that the synthesis of gallic acid leads to the artificial production of gall-nuts."

Twenty years later another President of the British Association[2] arose once more to prophesy that living protoplasm was shortly to be demonstrated. It has been noticed that it is always biologists and never chemists or physicists who draw extravagant cheques on the bank of Chemistry and Physics. So it was in this case, and again the cheque was returned marked "no effects" by the chemists and physicists, who with one accord declared that the solution of the problem in question was no nearer than it had ever been. With regard to the assertion with which we are now dealing, it may be at least said that no one asserts that living matter *has* been made by the chemist, and that it *will* be made is a prophecy which may or may not come true.

[1] Presidential Address to the British Association.
[2] Professor, now Sir E. Schäfer, in 1911.

In the third place, it is occasionally asserted that though living matter has never yet been made, something on the way to being alive has been produced artificially. To this it may be replied that a thing must be either living or not living, and that it is impossible to conceive of a thing which is half-and-half. This impossibility of conceiving such a thing, by the way, is one of the best proofs of the abyss which stretches between life in its simplest manifestations and not-living matter. It may be added that these half-way houses have been shown to be purely physical manifestations explicable on purely physical lines.

How then did life arise? "God created it" is the Catholic answer—indeed the answer of all Christians; and this simple and sufficient reply holds the field. Reinke, a distinguished botanist, declares:[1] "If we agree that living matter has at some time come from inorganic substances, then, in my opinion, the Creation hypothesis is the only one which meets the necessities of logic and of causality and therewith answers to the needs of a prudent seeker after Nature."

With which statement we may leave the question of the origin of life.

[1] "Einleitung in die theoretische Biologie," s. 559.

CHAPTER XXXI

TRANSFORMISM—SOME PRELIMINARY CONSIDERATIONS

IN the foregoing chapters we have endeavoured to discuss two important questions in connection with Life. In the first place, we had to consider whether there really is such a thing as Life, or whether the manifestations which we have come to connect with that name are in fact nothing more than higher manifestations of those chemical and physical processes with which in simpler forms we are familiar in everyday existence. The answer suggested to that question is that there is a radical difference between the phenomena of Life and the phenomena of chemistry and physics, and that the former cannot now be and never can be stated fully in terms of the latter. The difference lies in the existence in living matter of a vital principle which dominates the material substance with which it is associated.

We next considered the origin of life, and found the entire scientific world averse from the solution of spontaneous generation, whether as an event of to-day or of the remote past.

Life, as far as we can trace it, has always come from life: how then did it originate? There is, of course, the agnostic position which takes Life as an existing fact and refuses to ask how it originally came into being, believing that no answer to such a question can be expected. With those who contentedly hold such a position there can be no argument. All the theories which they may subsequently weave are good, or may be good, so long as one is content to remain within the system which they have set up and within which they are working; but they do not explain

the system, still less anything which is outside it. Further, it is obvious that if the system which they assume should prove to have been falsely assumed, all that has rested on that assumption must necessarily fall to the ground.

We may leave this attitude of mind on one side, since it confessedly ignores the matter with which we are concerned. We have agreed that there is such a thing as Life; that it differs in kind from what we may for the moment speak of as Not-Life; that it must have had a beginning. Taking all these things into consideration, we can have little difficulty in accepting, with a large number of scientific persons, not to speak of all believers in revealed religion, the statement that Life was created by an Omnipotent Creator. In fact, things as they are necessitate our believing in a Creator and in postulating such a Being in order to explain them, even if we had no revelation to give us information concerning Him. On this point something more must be said when we come to deal with the so-called Argument from Design. Meanwhile, it may be pointed out that the belief to which we have been alluding is neither the beginning nor the end of our idea of the powers and actions of the Creator in connection with the physical facts of this planet. It is not the beginning, because He created Matter before He gave rise to Life; and it is not the end, for His action with regard to Life obviously does not end with the origination thereof. The Creator of Life by that very fact and in that very act must have foreseen, intended and created all the manifestations of Life which have been, are, or may yet be. This statement brings us face to face with the Theory of Evolution, or Darwinism, as it is commonly but, as we shall see, most erroneously called—a title under which it has been misrepresented, argued over, misunderstood, extolled and hated, perhaps more than any theory which has ever been before the public. It will be necessary to devote much consideration to this matter, for reasons which will be perfectly obvious to all readers.

Before, however, getting to the heart of the controversy, there are certain preliminary considerations which, as it seems to the present writer, must be taken into con-

sideration in any discussion of the matter; the neglect of which, in fact, has led to a good deal of misconception.

In approaching those which deal with theological problems, no one can be more aware than the present writer of the difficulty of the task. It is intensely difficult for anyone who has not had a prolonged training in Theology even to touch the fringe of comprehension of such questions as are involved in the matter with which we are now concerned. Huxley once exulted in having "plucked the heart" out of Suarez during a summer afternoon spent in the library of a Scottish University. He would have been deeply indignant if some theologian had ventured to make a similar claim in connection with some profound embryological monograph: how he would have derided the man who imagined that, without learning the language of science, he was yet able to penetrate the meaning of those who wrote in that language! But Scholastic Philosophy and Theology have their own language, which is not to be learnt in a day nor picked up "as one goes along." It is ignorance or neglect of this simple but most important fact which has led to so many misconceptions and misunderstandings, not only on the part of men of science but also on the part of would-be defenders of the faith who have at times done more harm to the cause which they desired to support than has been effected by those whose aim in life was to destroy it.

It is with this warning before my eyes and with every submission of what I say to those who are far more conversant with the matter than I am or am ever likely to be, that I venture to set down the following points, which seem to me to assist in coming to a right conclusion on this matter.

It may seem like a platitude to remark in the first place that the Creator is not a superior kind of human being. Yet it is the cardinal point which we have to keep before us. Of course, it is a commonplace of Theology, but I am speaking of and to non-theologically instructed persons. St. Thomas Aquinas says,[1] "Nullum nomen univoce de Deo et creaturis predicatur." There is nothing; no, not

[1] "Summa," Pars i., qu. xiii., art. v.

even existence, as regards which we can speak in common terms of the Creator and the beings whom He has created. Of course we cannot help thinking of the Creator in an anthropomorphic manner. There is no moral delinquency in doing so ; it is, in fact, impossible for us to do otherwise. We cannot look higher than our eyesight will carry us. Imagination will penetrate further than the most powerful telescope ; and imagination will at least help us to understand that whatever we may think of the Creator, the reality must far transcend our thought. And further, it will enable us to realise, what of course is the case, that our inaccuracies are not only great but that they are inaccuracies of quality far more than inaccuracies of quantity.

We have just seen that not even existence can be postulated of God and man in common terms, and this brings us to the subject of Eternity. All of us, I suppose, think of this as being a very greatly prolonged Time—prolonged backwards and prolonged forwards, never having a beginning nor an end but always going on. According to the teaching of Catholic Philosophy, Eternity is not this at all. It is defined as " possession, without succession and perfect, of interminable life." The life of God in Eternity, to use our quite inadequate phraseology, is " not only without beginning or end, but also without succession—*tota simul*—that is without past or future ; a never-changing instant or 'now.' "[1] " In God," writes Fr. Boedder,[2] " there is no kind of succession, and where there is no succession there is no time." It does not appear that in the controversy which we are now commencing to discuss what I may venture to call the " Nowness " of God has been sufficiently considered.

If it is difficult for the ordinary person to think of the Creator in other than human terms, so also is it difficult for him to think otherwise of the Creation. At the best he is likely to think of a superhuman intelligence at work, but only of a superhuman intelligence, a human intelligence raised to the n^{th} power. Moreover, he is likely to think of this intelligence as arranging things in a succession of events, perhaps even at successive times, nay, perhaps even with

[1] " Catholic Encyclopædia," *sub voce* " Eternity."
[2] " Natural Theology," Stonyhurst Series, p. 158.

reconsiderations at different epochs. Indeed, with all reverence it may be said that those who think about the subject at all are tempted to think of creation as effected by a very superior kind of man sitting down daily to consider the task that was accomplished yesterday, and that which must be attacked to-day.

No doubt the position thus indicated is excused by the fact that it seems to be that adopted by the writer of Genesis ; and for very obvious reasons. The writer of that book certainly intended to make it clear that God created everything ; and, whatever other lessons he may have desired to teach, it seems also clear that he desired to teach mankind that there was a succession in the events of creation (see Chapter XVI). These things the writer of the Sacred Book had to bring before the simple people for whom he wrote, in language which they could understand : any other kind of account would have been quite incomprehensible to them—in fact, the very statements about the Creator which have just been made are incomprehensible to all of us. This is no more than to say that God is inscrutable and incomprehensible to His creatures : if He were not so, they would be His equals and not His creatures.

To return to our main thesis, we must recognise that the idea which, without putting it into so many words, one is liable to form of God and of His creation—as that of a vastly superhuman Being slowly evolving the course of Nature by successive ideas and successive operations—is not only inadequate but positively ridiculous. How ridiculous it is becomes the more obvious the more we meditate upon the fact that there is no succession with God but that everything is *Now*.

If we once get this idea clearly into our minds and couple with it the idea—very much less difficult to realise—of God's Omnipotence, we can at once begin to look at the controversy as to Evolution from a totally different angle. We approach it from the standpoint of a Creator, and we do so because the central and primary point of importance is the acceptance of a Creator and the comprehension of His attributes. Beside this all other matters are of secondary importance. Whether the products of Life came into exist-

ence suddenly or slowly and gradually; whether, in the latter case, there were epochs of greater or lesser activity or a constant steady stream of progress; whether there were times at which fresh forms of life arose without connection with those already in existence; whether evolution, if evolution there were, was mono- or poly-phyletic—all these things sink into minor importance when we remember that God is Omnipotent and that with Him there is no succession.

Whatever may have been the process of Creation, it was a process of Creation ordained by the Creator. Assuming that—to speak humanly—God had His plan; that He saw in His ideas countless possible worlds to their minutest details; that He selected one and said, "Let it be," then this world would come into being and evolve as foreseen by God, God Himself remaining unchanged during the process of variation and evolution. Immediate Divine formation and mediate production through evolution are equally possible to God.

Another matter which requires mention is the statement which is sometimes made that God "interferes" or "intervenes" in the progress of natural operations. The terms are inadequate, hopelessly inadequate, as are all terms which we are obliged to use in this connection. Here again, if we keep constantly before our minds the "Nowness" of God, we shall be kept clear of the obvious absurdity of thinking that He is called upon from time to time, like the captain of a ship or the generalissimo of some great army, to come to a decision respecting some hitherto unexpected phase of events. The terms just alluded to are really a matter of that technical language of Theology which, as has already been said, must be learnt before the content of the subject itself can be appreciated. The Divine Act can be considered in itself (*entativé*, to use the theological term) or in the term produced (*terminativé*).

Considered *terminativé* one could speak of a multitude of divine acts; but the Divine Act in itself, the Act that produced all these terms or effects, is really one.[1]

[1] I owe this explanation, and some of the other points in this chapter, to a kind and erudite theological friend to whom my gratitude is due. He adds in this connection an illustration which may be of as much value to

Creation—with that continuance of the stream of life and its development, not to speak of the guidance of the same which that word entails—is not, in our common acceptation of the term, an " interference " with the laws of nature. The point to keep constantly before our minds is that creation really is the institution of those very laws. The creation of Life and the formulation of the Laws under which it was to work : each of these simultaneous operations forms part of the Act of Creation. Again, to use our inadequate terminology, we must not look upon what we may call " interferences " as unpremeditated. As far as I know, theological writers and the Fathers of the Church are never tired of insisting on law and regularity and of warning us against the idea of arbitrary interventions.

We cannot understand what is meant by Eternity : that is obvious. But we can at least understand that it is something wholly different from Time. Further, we can understand that if we try to think about Creation in terms of Time when it is only comprehensible in terms of Eternity, we shall find ourselves in impenetrable thickets of difficulty and confusion.

So much has been said because the present writer has often noticed that unnecessary difficulties arise in the mind, as a result of the consideration of matters to be dealt with in the next few chapters, for want of a due appreciation of the points to which reference has been made above. So far

others as it has been to me, both in connection with the point under consideration as well as that of Miracles themselves, considered in Chapter XIV. He says: " So one might speak of Divine ' interferences ' in relation to miracles ; but the term always requires some explanation. In relation to God we speak of the *natural* power and the *obediential* power of things. They are convenient terms. If we take a field with its natural elements and seed and moisture and the light and heat of the sun, it has the *natural* power of bearing grass or some other crop. If we suppose a field with its mineral and chemical elements, with moisture and with the light and heat of the sun, *but without any seed or germ of life*, leaving out spontaneous generation, it cannot vegetate ; it has not the power of vegetation. But God could make it vegetate without putting what we call ' seed ' into it, simply by His word. We say the field has the capacity of ' obeying ' the word of God, and we call this power the *potentia obedientialis* of nature. But God would have foreseen all from eternity, and would have decreed one series of events as well as the other, by the same Divine Act. Both series might thus be said to obey law, but one series comes from the permanent powers of nature : the other series does not ; and consequently when we see a miracle it brings vividly before us the fact that there must be some Power other than created nature."

as we are concerned for the moment, the great fundamental facts are that there is a Creator and a creation.

But it remains to be said that there are at least two conceptions of that Creator, a Catholic conception and another. This not being a treatise of Theology, it may be sufficient to warn readers, if indeed such warning be necessary, that the God of Catholic Theology transcends His creation which indeed is only the representation of the Divine Idea.

The God of such writers as Bergson in his " Creative Evolution," a being immanent in the universe and ignorant of the direction in which evolution is making its progress, is not the God of Catholic Theology. Nor, we may perhaps add, is this an idea of God which in any way satisfies the limited conception which our imagination is alone capable of forming. To the plain man it seems clear that God must be greater than His work, and that He must know what He is doing. A force—one cannot call it a Deity—which urges matter on without knowing in what direction or to what ends it is being urged may be called a God by those who believe in it, but it is nothing else than our old friend Blind Chance, posing under a new name.

CHAPTER XXXII

TRANSFORMISM AND CREATION

THERE are still quite a number of persons who suppose that Darwinism and Transformism are exactly the same thing, and that no one had ever thought of such a thing as derivative creation, or of what is often called evolution, until Darwin brought it before the world in his famous book. Of course no educated person entertains this idea, which has been exploded in numerous books for and against the distinctive Darwinian views. From our point of view, it is interesting to note that the question has been one of debate amongst the Fathers of the Church from the earliest times.

Reduced to its simplest form, transformism means that, instead of making a sudden appearance from nothing, all forms of life may have developed from other forms of life, commencing with one simple undifferentiated form or perhaps with a few such forms. From such lowly unicellular form or forms there would branch off on the one hand animals and on the other plants: each of these would afford other divergencies until the present state of affairs was reached. The lines of developments, the branchings and dichotomies, form the subject of the study known as Phylogeny. Such, in brief, is what is meant by transformism.

Now, no believer in an Omnipotent Creator will doubt that it was possible for Him in an instant of time to create the world, animals, plants and all—nay, even the fossil remains in the world—if He chose to do so. All this is involved in the theory of an Omnipotent Creator. He could do this if He chose; but obviously He could also by His fiat direct that things should develop gradually and from one another by a process of mediate creation. From Genesis we know

that the Creator did not create the world with its plants and animals simultaneously—simultaneously, that is, from our point of view, not from the standpoint of God, in whom, as we have seen, there is no succession. What we do know is that He created things or allowed things to come into existence by stages. This matter has been already dealt with in connection with the question of the Creation.[1] The question as to whether things living appeared suddenly out of nothing, or whether, once life was created, they developed from earlier forms is the question of immediate or mediate creation; and both of these, as we have seen, are equally possible to an Omnipotent Creator. This topic has been freely debated by the Fathers of the Church ever since the time of St. Augustine. Though Darwin did not originate the theory of transformism it was the influence of his book that made it a really live question in modern times. Prior to this, this matter had been one of little more than academic interest, and quite undebated by the man in the street. Even the publication of Chambers's "Vestiges of the Natural History of Creation," which appeared some time before Darwin burst upon the world, had but little real influence, and awakened comparatively little interest even in the minds of the reading public.[2] After the issue of Darwin's book a storm of controversy arose, and one of its most effective critics was the late Professor Mivart.[3] With the special criticism of Natural Selection with which the book was concerned we need not deal. The point of interest at present is the chapter entitled "Theology and Evolution," of which some account may be given, as the book is out of print and hardly likely to come into the hands of most readers.

The writer first discusses what is meant by creation, distinguishing between immediate and mediate or derivative creation; he then proceeds to show—what, at that time at least, most persons certainly would hardly have

[1] See Chapters XVI and XVII.

[2] This book was published anonymously in 1844; the "Origin of Species" did not appear until fifteen years later.

[3] "On the Genesis of Species." The author was then and for many years later a devout Catholic. It is understood that he never deviated from the views and criticisms expressed in the above-named work.

expected—that doctrines indistinguishable from that formulated by Darwin as to descent—apart of course from his subsidiary theories such as Natural Selection—were put forward by some of the greatest ecclesiastical authorities. St. Augustine, for example, speaks of a "potential" creation of animals, the actual examples themselves only to appear in later times.[1] This "potential" creation, which is the same thing as mediate or derivative creation as spoken of above, is approved of by St. Thomas Aquinas, by Cornelius à Lapide and by Suarez. I am well aware that St. Augustine's assent to the theory of mediate creation has been disputed; as this is a question for theologians and critics, I shall not venture to intervene in it beyond saying that Mivart, with the authorities cited by him, certainly read St. Augustine in this way. So did Peter Lombard, and so, I understand, does the Augustinian School of Theology. Further, to the plain man, any other explanation of St. Augustine's writings seems forced if not impossible.[2]

But what is of real importance and what cannot be gainsaid, is the fact that mediate creation has been a subject of discussion amongst theologians since the time of St. Augustine, if no earlier, and that it has been received with approval by some at least of them. Again, it may be well to call attention to the fact that the essential thing is the word *Creation*—the method thereof, though vastly important, being much less so than the central truth insisted on in the

[1] "Terrestria animalia, tanquam ex ultimo elemento mundi ultima; nihilominus potentialiter, quorum numeros tempus postea visibiliter explicaret," De Genesi ad Litt., lib. v., cap. No. 14 in Ben. Edit., Vol. III, p. 186. I give the quotation and reference on the authority of the book from which I am quoting.

[2] Those who desire to follow this controversy further will find it very fully dealt with in "The Irish Ecclesiastical Record," Vol. V, January to June, 1899. Fr. Burton, C.M., denies that St. Augustine was an evolutionist. Fr. P. F. Coakley, O.S.A., takes up and defends the traditional view as to the Saint. Fr. Coakley, p. 353, submits that with regard to the passages in question from the works of the Saint, "their natural interpretation, and, consequently, St. Augustine's meaning, is that 'God, simultaneously with the creation of the world, created all living things, not in the perfect species now known to us, but in certain primordial forms, from which, in the course of ages, under the administration of Providence operating through secondary causes, all existing organisms are evolved.' That this proposition faithfully represents the mind of Augustine will be evident by comparing its various clauses with the passages quoted; and by comparing it with, say, Darwin's definitions, it will likewise be seen to embody the essential elements of the evolutionary hypothesis."

function and work of a Creator. Perhaps here it may be well to clear away another misconception. There were a certain number of people who rejoiced in Darwin's theory because they thought that it did away with the necessity for a Creator. There are even to-day, incredible as it may seem, ignorant people who suppose that Darwin " knocked the bottom," as they would put it, out of revelation and the belief in a Creator. Such persons can never have read Darwin's best-known book—indeed it may be suspected that many of those who talk most loudly (and often, it may be added most ignorantly) about these topics, owe their acquaintance, such as it is, with Darwin and his ideas to some one or more of the many misleading little manuals which issue from the Press on the subject of evolution. At any rate Darwin, himself[1] concluded his work with the following words, often quoted and now to be quoted once more : " There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one ; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved." It is of further interest to know, as we do, that the words, " perhaps into only one," were written into the original draft of the passage in pencil—the rest being in ink—and were, therefore, in the nature of an afterthought. Though his religious views became more and more nebulous, as he himself admits, until the end of his life Darwin allowed the quoted passage to stand in his greatest work. He thus admits that the possibility of a Creator and a Creation is in nowise lessened by his theory. That Creation is quite compatible with transformism has been admitted by Huxley and indeed, it may be said, by almost every scientific man who has written on the subject.

We must be clear what this means : many of them do not accept Creation as Catholics understand the word. Such men would say that they do not know how things began and care only to study them as they find them

[1] In the " Origin of Species," etc., 6th ed., Vol. II, p. 305. See also the " Foundations of the Origin of Species," 1909, pp. 52, n. 2, and 254, n. 4.

existing. But there is not one man who can maintain, if challenged, that the idea of Creation and a Creator is incompatible with a belief in some theory of transformism. Nay more, as we have already seen, it is claimed by some of them at least (apart from believers in a revelation) that creation must be assumed, if we are to form any theory as to how things began. Once for all, then, it may be laid down that the doctrine of transformism does not and cannot dispense with the need for or belief in a Creator: nor, it may be added, do any or all of the doctrines, whether true or not, included under the general term of Darwinism.

Further, it has been claimed by some of the most active supporters of Darwin's views that mediate creation gives a more elevated idea of the Creator than the other theory. The late A. R. Wallace[1] said: "Why should we suppose the machine too complicated to have been designed by the Creator so complete that it would necessarily work out harmonious results? The theory of 'continual interference' is a limitation of the Creator's power. It assumes that He could not work by pure law in the organic, as He has done in the inorganic world."[2] Charles Kingsley, who was a firm believer in Revelation as well as an acceptor of the theory of transformism, puts the point in question into the form of an allegory in his delightful book "The Water-Babies"—a work which, though marred by some of the characteristic gibes at Catholicity from which its writer could never abstain, contains much wisdom and, for those who can understand it, a very complete exposition of the philosophy of a Christian man of science. When Tom, the Water-Baby, reached the Peace Pool in the course of his wanderings he found Mother Carey sitting in the centre "making old beasts into new all the year round." She took the form of "the grandest old lady he had ever seen—a white marble lady, sitting on a white marble throne. And from the foot of the throne there swum away, out and out into the sea, millions of new-born creatures of more shapes and colours than man ever dreamed. And they were Mother

[1] "Natural Selection," p. 280.

[2] The reader will note the confusion as to the word "interference," which has been dealt with in the preceding chapter.

Carey's children, whom she makes out of the sea-water all day long. He expected, of course—like some grown people who ought to know better—to find her snipping, piecing, fitting, stitching, cobbling, basting, filing, planing, hammering, turning, polishing, moulding, measuring, chiselling, clipping, and so forth, as men do when they go to work to make anything. But, instead of that, she sat quite still with her chin upon her hand, looking down into the sea with two great grand eyes, as blue as the sea itself."

Tom told her that he had heard that she was "always making new beasts out of old." To which she replied, "So people fancy. But I am not going to trouble myself to make things, my little dear. I sit here and make them make themselves."[1]

We may conclude, then, that a belief in transformism does not in any kind of way exclude a belief in Creation and a Creator, but that in the opinion of a number of authorities it gives one, if possible, an even greater and wider idea of the greatness and wisdom of the Maker of all things.

The erudite Jesuit Father Wasmann[2] maintains, with not a few other men of science, that "a reasonable theory of evolution necessitates our assuming the existence of a personal Creator"; he sketches the outlines of the problem which we have been discussing, introducing a further element which must not be passed over in silence. He says:[3] "In order to explain the origin of the existing species of plants and animals, we have to assume one of two things. We may assume that the systematic species (e.g. lion, tiger, polar bear) are invariable—apart from the formation of

[1] The following parable addressed to those who hope to make a "homunculus in a retort" may be quoted for the sake of any unfamiliar with Kingsley's book. "There was once a fairy who was so clever that she found out how to make butterflies. I don't mean sham ones; no: but real live ones, which would fly, and eat, and lay eggs, and do everything that they ought; and she was so proud of her skill that she went flying straight off to the North Pole, to boast to Mother Carey how she could make butterflies. But Mother Carey laughed: 'Know, silly child,' she said, 'that anyone can make things, if they will take time and trouble enough: but it is not every one who, like me, can make things make themselves.'"

[2] In "Modern Biology and the Theory of Evolution," p xxii (first appeared in German in 1906), London, Kegan Paul, 1910.

[3] P. 255 *seq*.

varieties and breeds within the species—and that they were created originally in their present form. Or we may assume that the systematic species are variable, and constitute definite lines of descent, within which an evolution of species has taken place during the geological periods. The first of these assumptions belongs to the theory of permanence, the second to the theory of evolution or descent. In the latter we must make a further distinction between monophyletic and polyphyletic evolution. According to the monophyletic theory, all organisms have originated in one single primitive cell, or perhaps there is one pedigree for all animals and one for all plants, each having one primitive ancestor. According to the polyphyletic theory there are several pedigrees for both plants and animals, independent of one another, but each one going back to one special primitive form as its starting-point. In the following pages," he continues, "we shall see that the latter assumption alone can claim to have any positive scientific probability—and we shall see, moreover, that this assumption is perfectly reconcilable with the Christian doctrine of the Creation."

Into the discussion as to the two theories of evolution just propounded it will not be possible to enter here, nor would it be in place in what is avowedly only an outline of the controversy as it affects religious ideas. From the point of view urged in the previous chapter as to the absence of succession in Eternity and the Creator, it makes little if any matter whether scientific men eventually accept mono- or polyphyletic evolution as the better explanation. The act of Creation was single in either case—indeed, in any case—and may be thought of in that way, however the consequences of that act may have extended over untold ages.

We may now pass from this comparatively simple matter to consider some of the numerous theories and problems included under the head of Darwinism—though some of them were unknown to Darwin and others have been modified so that he would hardly recognise them and would possibly even have found it necessary to oppose them.

CHAPTER XXXIII

TRANSFORMISM—HEREDITY AND VARIATION

EVERY theory of transformism is based upon and must take into account two prime factors: Heredity and Variation.

To put the thing into simple language, it must be obvious, even to the most unobservant, that the offspring of any couple, whilst more or less resembling that couple, also more or less depart from their standard. In other words, they inherit a general resemblance but they have varied slightly, so that they do not present absolute facsimiles of their parents. Those who have not thought about the matter may say that there are numerous cases in which the offspring do not resemble their parents; but that is taking a narrow view of the matter. No one has ever heard of a cat giving birth to a dog, nor would a coloured child be expected to proceed from parents of unmixed European blood. The real wonder of heredity, which has ceased to be a wonder because it is so universal, is the fact that species breed true.

That there are small differences, which may be either absolutely or relatively small, is the result of the second factor, that of variation.

There are only two ways in which the biologist can deal with these problems: he can try to explain them, or he can assume them and pass to the consideration of the laws of both or of either of them so far as such can be observed. Darwin—without better success than others, as we shall see—tried to explain heredity whilst he assumed variation. Lamarck, with whose theories we shall shortly be concerned, tried to explain—some think did explain—variation, but assumed heredity. It will be convenient to devote a short

time to these two factors before proceeding to discuss the more important theories associated with the name of Darwin.

Let us commence with heredity, as to which it may at once be said that whilst we know a good deal about its operations, we know little or nothing about its mechanism. If heredity acts through material mechanism, it seems probable that it may be the chromosomes (see Chapter XXV and Note to Chapter) which are its vehicle. In the union of a male cell with a female to form the fertilised ovum, an equal number of chromosomes from the one unite with the same number from the other. Thus the normal number of chromosomes in a cell being—let us say—sixteen, the fertilised ovum will contain the same number, of which eight will have come from the male and eight from the female cell. Moreover, in each of these cells there will have previously taken place a reduction whereby the normal chromosomes of the cell have been reduced to half their number. The union then of what we may look upon as two half-cells constitutes once more a complete cell, with the full number of chromosomes normal to the species; and the cell thus completed is the embryo from which the future individual is developed. Evidently there is a profound significance about the chromosomes, though at present we cannot prove exactly what it is. It may be that its true meaning is impenetrable by our methods or instruments.

Darwin was not aware of the facts concerning the chromosomes which have been discovered since his time by the use of more powerful microscopes and improved processes of staining[1] the objects which are to be examined. But he assumed a mechanical vehicle for the transmission of hereditary characters and gave his theory the name of Pangenesis. In considering it or any other theory of heredity, we must bear in mind the fact that extraordinarily trivial defects or peculiarities of structure may be as faithfully handed down as the grosser features, such as colour and the like. Everybody has heard of the Hapsburg lip, and every-

[1] The exceedingly thin slices or "sections" of animal tissues are coloured or "stained" by various pigments such as logwood or aniline dyes to render their various characteristic features more readily recognizable. The technique of staining has been brought to great perfection since the days of Darwin.

body must be aware of other small characters—such as the peculiar set of the hair, the eyebrow and the like—which have been handed down for generations in the same family. Darwin's theory assumed that extraordinarily small germs or fragments from all parts of the body were collected into the male and female reproductive cells, and that when these cells had united, the infinitesimally tiny fragments started to grow, and thus reproduced an individual similar to those from which they had sprung. Others than Darwin have looked favourably on the same theory, and it is certain that no one can prove to demonstration that it may not be true. But it is certain that biologists for the most part have abandoned the micromerist theories, as Delage has named those explanations which depend on the assumption of the collection of minute fragments from different parts of the body in the germ-cells.

In the first place, it has been calculated that it would require some trillions of minute fragments to meet the necessities of the representation of all parts of the body capable of independent variation. Then again it has to be remembered that heredity does not confine itself to the characteristics of the immediate progenitors of the offspring. Everybody knows that children may "throw back" to a grandparent or even to a more distant ancestor, and all breeders of dogs and cattle are aware that an ancestor, tainted from the breeder's point of view, may exhibit itself in the progeny of a generation much later than that which immediately followed upon the taint; and that, although nothing but pure strains have been employed since that period. Hence Pangenesis or any other micromeric theory demands a complexity so utterly beyond conception as to defy belief. "Any theory which involves the assumption of morphological units as representing characters must bring us to an *impasse* in a very few generations, as is demonstrated by the working out of such a theory to comparatively few degrees upward from offspring to parents, grandparents and so on."[1]

Whether it be the chromosomes or, as some think, some

[1] Walker, "Hereditary Characters and their Mode of Transmission," London, Edwin Arnold, 1910, p. 121.

other constituent of the cell, the micromerist theory seems to break down. Can it be replaced by any other of a material character? Samuel Butler, the author of "Erewhon" and a number of other books far less well known than they deserve to be, published in 1880 his "Unconscious Memory."[1] In this he gives a translation of Hering's address of ten years previously,[2] in which he urges that it is the memory of the past in the germ which causes the embryo to develop into something closely resembling the stock from which it sprung and which it unconsciously remembers. This memory may be thought of as an immaterial or a material phenomenon. The point, as indeed all the points which we are considering in the present connection, is of purely scientific and philosophical interest; for whichever explanation we accept, no religious difficulty is suggested. It is quite clear that an immaterial explanation can be given, and it is equally true that it can neither be proved nor disproved. Hering adopted a material explanation and made the mechanism of memory reside in certain "vibrations of the protoplasm and the acquired capacity to respond to such vibrations once felt upon their repetition."[3]

Butler adopted this material explanation even more warmly than its parent had done. In his earlier writings he certainly leant strongly to the side of dualism, but in this book he appears as a materialistic monist, since he declares that the only thing of which he is sure is "that the distinction between the organic and inorganic is arbitrary." Now it is well known that there are certain physical facts, such as the behaviour of wire which has been submitted to torsion, which suggest something simulating memory in non-living matter. This is not a philosophical treatise, so that the question need not be further pursued than to say that, as in the former case, it is not possible to prove that transmitted vibrations of the protoplasm may

[1] Republished in the Collected Edition of Butler's works, Fifield, London, 1910.

[2] "Das Gedachtniss als allgemeine Funktion der organisirter Substanz," given as an Inaugural Address to the Imperial Royal Academy of Sciences at Vienna, in 1870.

[3] For a résumé of the question see Hartog's excellent Introduction to Butler's Works in "Unconscious Memory."

not be the mechanism of a memory which controls and directs heredity. Nor does this present any difficulty from the vitalistic point of view, since it in no way accounts for variation nor for the powers of modification which the living thing has been shown to present. Nevertheless it may be admitted that the so-called mnemic theory with which we have been dealing has never as yet secured any real support in the scientific world. This is in part due to the fact that it is impossible to prove it: in part it is certainly due to the unwillingness of many to adopt the mnemic explanation on account of what they would call its mystical character.

The upshot of the whole matter is that we know very well that there is such a thing as heredity, but we do not know what its mechanism is. It is a case exactly parallel to that of Gravitation. This ignorance of the vehicle of heredity is very clearly exemplified by the statements made by Bateson in his Presidential Address to the British Association.[1] He says, "The allotment of characteristics among offspring is not accomplished by the exudation of drops of a tincture representing the sum of the characteristics of the parent organism, but by a process of *cell-division*, in which numbers of these characters, or rather the elements upon which they depend, are sorted out among the resulting germ-cells in an orderly fashion. What these elements, or *factors* as we call them, are we do not know. That they are in some way directly transmitted by the material of the ovum and the spermatozoon is obvious, but it seems to me unlikely that they are in any simple or literal sense material particles. I suspect rather that their properties depend on some phenomenon of arrangement."

It is worth while pausing for a moment to consider two points in this utterance. In the first place, as regards material and immaterial. "Particles" must be material, though they might have immaterial connections, relations, or perhaps guidance. But once we assume immateriality, it is obvious that we are engaged in metaphysics; indeed in what many persons—including, we fancy, the author of this address—would stigmatize as "mysticism."

[1] 1914, "Melbourne Address," p. 5.

Again, what is meant by "arrangement"? The disposition of the particles in the germ? Who arranges them and under what laws are they arranged? To this no answer is given. The whole matter is another example of the impossibility of attempting to give a complete answer to these difficulties without assuming the hypothesis of a Creator and Maintainer of Creation and of Laws of Existence founded and enforced by Him. It is the attempt to turn the flank of this theory which leads to explanations of the kind quoted, which explain nothing, since they do not explain who does the arranging or how the "arrangement" takes place. The "explanation" thus becomes purely verbal.[1]

Returning from this momentary digression we must, before leaving this branch of our subject, consider one further important point. Can all the features, natural and acquired, which are presented by the progenitors be inherited by the offspring? Around this question there has raged a vigorous and still undecided controversy, as indeed is not wonderful having regard to the importance of the matter in connection with certain grave problems. This will shortly be made more clear. Let us take the problem piecemeal. Suppose a man has had his leg cut off, is it likely that his offspring will be one-legged? To ask the question is to answer it; yet up to a recent time it was scarcely doubted that mutilations of other kinds might be inherited. As far as anything in the shape of a negative can be proved, Weismann, in a series of papers, did in my opinion prove that mutilations are not heritable.[2] But suppose a man has all his life exercised the muscles of his

[1] Of course the familiar retort is that our explanation of a Creator and that of a vital principle are equally "verbal." The reply to this is that by a process of exclusion and by other lines of argument pursued elsewhere in this book we can, so we maintain, show the existence of a Creator and, by another line of argument, of a vital principle. If we can do this we are entitled to argue that the Creator's power is manifested in the directions under discussion,—in other words, that through His undying laws He is the "arranger." Our contention has at least the advantage of being logical and complete, neither of which epithets can be applied to the other attempted solution.

[2] In making this statement I am not ignoring the standard argument of those who differ from me on this point, namely, Brown-Séquard's epileptic guinea-pigs. This experiment does not in any way convince me.

arms as a blacksmith, is his son more likely to possess muscular arms than the son of a literary man who has never worked at anything more laborious than a type-writer? Here we come to a more difficult question and one far less capable of solution by experiment. And it becomes still more difficult of solution if we extend the question: is the son of a blacksmith, who is also the grandson, the great-grandson and the great-great-grandson of blacksmiths, likely to be born with better and more muscular arms than the descendant of generations of writers? Or take another case, illustrating another form of environment. The emigrant from England to some tropic clime gets a tanned face: in the course of generations is this tanned face likely to become a hereditary characteristic? In other words, can the environment, taking that word in its widest sense, produce any effect on heredity? Weismann and those of his school answer definitely in the negative. According to their view the germplasm is segregated from the plasm of the body proper in the very earliest stages of development and cannot be influenced by anything which affects the body save such things as bacterial infection, which may attack it just as they may attack the child after it has been born. When committing himself to this doctrine Weismann took up a position which made it very difficult to account for variation—impossible to do so in fact without appealing to an internal impulse inexplicable on purely materialistic grounds or without resorting (as we shall see that he did) to a fantastic and utterly unprovable hypothesis.

If heredity were an absolutely rigid thing, then there must result absolute and unvarying identity in a family or a species. We know that this is not the case, but that all sorts at least of minor differences are exhibited which are the result of what we call Variation. How does Variation come about? Is the impetus from without or from within or from both? Weismannians declare that it is not from without: Lamarckians and the so-called Neo-Lamarckians claim that it may come from without; and indeed whatever may be said of the inherit-ance from one generation to the next, it is hard to believe that the accumulated influence of the environment over

several generations is unable to produce any effect upon the germ and upon the offspring.[1]

We turn, therefore, to the question of variation. No one doubts that the thing is there: can we in any way account for it?

Lamarck was a distinguished French botanist and zoologist born in 1744. He seems at first to have believed in the fixity of species; but after deserting botany for zoology he changed his mind and in 1800 avowed his belief in transformism, saying that Nature, having formed the simplest organisms, "then with the aid of much time and favourable circumstances . . . formed all the others."[2] Moreover, he tried to explain how variation was brought about. According to his view use and disuse in animals chiefly bring about variations in organs, and new organs arise in response to a physiological need. In reference to this we must be careful to remember that it is not suggested that the animal thinks a certain organ would be useful to it and sets about securing it: such a suggestion would be ridiculous. What Lamarck suggests is, that a new condition having arisen in connection with a certain animal or group of animals of the same species leads to a reflex action as a result of which the new organ may arise. Further, he assumes that the new organ once acquired may be inherited by the offspring and thus handed down. When we come in the next chapter to discuss the question of Natural Selection we shall see the bearing of that theory on this suggestion. Meantime it need only be said that Lamarck's theory at least offers an explanation, whether true or false, of the origin of a variation which Darwin's theory does not.

One of the most convinced of the Neo-Lamarckians writes: "The theory of selection can never get over the difficulty of the origin of entirely new characters. . . . How can it be said that the horns of ruminants arose?

[1] Recent observations seem to indicate that the environment can and does effect much more than has of late years been thought possible. See Morgan's "Mechanism of Mendelian Heredity," Constable, London, 1915, p. 38 *seq.*

[2] For an interesting account of Lamarck and other biological pioneers, with the theories associated with their names, the reader may be referred to "Biology and its Makers," by William A. Lacy, New York, Henry Holt & Co., 1908.

No other mammals have ever been stated to possess two little symmetrical excrescences on their frontal bones as an occasional variation; what, then, caused such excrescences to appear in the ancestors of horned ruminants? Butting with the forehead would produce them, and no other cause can be suggested which would." Further, he continues: "There is evidence that physiological change precedes morphological. There is a climbing kangaroo in Papua which shows so little adaptation of structure to the climbing habit, that no naturalist would believe from the mere study of its body that it lived in trees. But as a matter of fact it does live entirely in trees."[1]

Darwin seems to some extent to have accepted the Lamarckian view, though he never made any real attempt to explain the origin of variation. Weismann, having excluded the Lamarckian explanation, and indeed any explanation which permitted the exercise of any external influence to count, found himself face to face with the difficulty of accounting for variation save by some internal impulse or power—in other words, by some vital principle—or by an explanation described in the language of his school as "mystical." Hence he erected an enormous edifice of assumptions[2] consisting of imaginary physical entities none of which are capable of demonstration under the microscope or by other means.

There is no doubt that this explanation would explain what requires to be explained; but it cannot be too carefully borne in mind, as already pointed out, that there may be twenty explanations of a given series of events, nineteen of which must be, and twenty of which may be utterly incorrect, though every one of them is capable of explaining the events in question. There is not a shadow of real evidence for Weismann's entities, and as a matter of fact they have not won acceptance in the biological world except with some few who, like Weismann himself, refuse to acknow-

[1] From the Preface to Cunningham's Translation of Eimer's "Organic Evolution," London, Macmillan, 1890.

[2] This will be found in his "Evolution Theory," transl., Thomson, London, Edward Arnold, 1904. For some criticism of the theory the reader may be referred to an article by the present writer in "A Century of Scientific Thought," London, Burns and Oates, 1915.

ledge the possibility of the action of external influences or the other possibility of the potency of vital action from within. Germinal Selection, Weismann's theory, can, as he admits, " no more be proved mathematically than any other biological process. No one who is unwilling to accept germinal selection can be compelled to do so, as he might be to accept the Pythagorean propositions. It is not built up from beneath upon axioms, but is an attempt at an explanation of a fact established by observation—the disappearance of disused parts. But when once the inheritance of functional modifications has been demonstrated to be a fallacy, and when it[1] has been shown that, even with the assumption of such inheritance, the disappearance of parts which are only *passively* useful, and of any parts whatever in sterile animal forms, remains unexplained, he who rejects germinal selection must renounce all attempt at explanation.[2] It is the same as in the case of personal selection. No one can demonstrate mathematically that any variation possesses selection value, but whoever rejects personal selection gives up hope of explaining adaptations, for these cannot be referred to purely internal forces of development."[3]

We must return to this when discussing the scientific value of the theory of Natural Selection.

[1] It may be noted that the writer assumes as proved in his favour the very things which his opponents dispute.

[2] The reader will note that this triumphant assertion is made by the author of the theory in question.

[3] *Op. cit.*, Vol. II, p. 121.

CHAPTER XXXIV

DARWIN AND NATURAL SELECTION

WE have seen that, in spite of the popular belief on the subject, Darwin did not invent the theory of transformism which has become so closely associated with his name. It had been discussed more or less spasmodically for centuries, but only by the learned and more or less academically. It was Darwin's lot to accomplish what Lamarck and Chambers had failed to do—namely, to focus the public interest on the question; to make the subject of evolution into a battle-cry between materialists and non-materialists—a position which it should never have occupied—and even to make out of it a curious yet most dangerous kind of religion or at least a rule of life.

That Darwin achieved this end quite unexpectedly to himself and with results which he can never have foreseen, was due no doubt in part to the fact that the "psychological moment"—to use a hackneyed phrase—had arrived; everything was ready for the coming of the idea. But, in large measure, the cause of the success of the book was that it offered, with magnificent wealth of proof of various kinds laboriously accumulated during many years at home and abroad, an explanation of how transformism might be carried out—in fact that it professed to demonstrate the mechanism of evolution. This is made quite clear by the full title of the book, which though generally shortened down into "The Origin of Species" and believed by many to be that and no more, is really "The Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life." In that title is briefly summarised the entire teaching of a book of several

hundred closely printed pages, which teaching we have now to submit to a brief examination.

If we look out upon the world we see a vast number of different species of plants and animals, all of them increasing and multiplying at a rapid rate. Yet the world does not become overfull of animals: if we look back over a number of years, we shall recognise that there are about the same number of birds of different kinds around us as there were in our childhood, and that the country is not overrun by the weeds which grow along the hedge sides; yet these birds and weeds multiply their numbers enormously every year. The explanation, of course, is that whilst numbers of new birds are hatched every year, numbers also die—so many, in fact, as to keep the general average, in any particular district which has not undergone great changes of some kind, about the same in a series of succeeding years. The careful farmer takes pains to see that the weeds do not invade his grounds to any harmful extent, and thus acts as an eliminating agent. An eliminating agent—that, in some shape or form, is what keeps down the numbers and prevents the whole face of the earth from being covered by innumerable swarms of animals of all kinds. If one-half or more likely three-fourths of these living things perish in their early days, is it merely chance or luck which leads to the survival of the remaining one-half or one-quarter? Darwin's theory was that, if one may so put it, external luck had nothing and internal luck everything to say to the survival of any particular individual Individuals vary; some of them will be stronger and better able to resist a period of shortness of food; some of them will be swifter of foot and better able to escape from those who would slay them. These favoured individuals would survive in the struggle for existence, would hand on to some at least of their progeny, and perhaps in an enhanced condition, those gifts by means of which they themselves had survived in the contest; by a gradual accumulation of small variations, first a "variety" and then a new "species" would be formed. Stripped of all its smaller details, this is what is meant by the phrase "Natural Selection": the selection made by Nature from amongst

myriads of individuals whereby favoured individuals survive in the struggle for existence. It may at once be said that, if we grant that mediate creation is acceptable, there can be no quarrel between religious dogma and this theory; for, as a mechanism devised by the Creator, it would fall into its place with a number of other orderly arrangements which we call Laws of Nature.

It remains to be seen whether it is or is not scientifically sound and what it can and cannot do. In the first place, it assumes but does not purport to explain the fact that variations do occur. In this it differs from the Lamarckian theory; the often-quoted example of the giraffe will well explain the difference which exists between the two. The long neck of this animal on Darwinian lines would be accounted for by the fact that, in some prolonged drought or other food-famine, those members of a species on the road to becoming what we call giraffes which had the longest necks could feed on leaves growing higher up on trees than those less well-provided in this respect, and hence would survive when their less favoured brethren must die. The longer necks would become hereditary, and still further elongate themselves and finally the giraffe, as it exists to-day, be evolved. It will be observed that this theory has to begin with a group of herbivorous animals alike in most respects but differing in that some of them have shorter, some longer necks. In other words, this theory "neglects" the origin of variation, which remains outside its system. Further, it assumes that the longer necks will be inherited—this is hardly an assumption, for abundant proof that such might occur is available. Lamarck, on the contrary, would explain the long neck by saying that the particular species in question, by constantly stretching after higher and yet higher branches, would, by the reflex stimulus thus set up, actually develop a longer neck. Here, it will be seen, we begin with the development of the variation—a point evaded by the Darwinian theory. On the other hand, we assume what the Weismannians and some at least of the neo-Darwinians would deny, namely, that acquired characters are heritable. We now see the difference between the two views, which are very sharply dis-

tinguishable the one from the other. It may be added that the supporters of either side wage war upon one another at times with scarcely less bitterness than the *odium theologicum* is said to provoke.

For a time Natural Selection simply swept the field. Its more ardent and less well informed supporters claimed for it a position which the author of the theory himself disclaimed. It is difficult to understand how they could have taken up such a position, but Darwin in later editions of his book was obliged to point out that those who believed that Natural Selection could account for the origin of variations were labouring under a mistake. Thus he writes: "Some have even imagined that Natural Selection induces variability, whereas it implies only the preservation of such variations as arise and are beneficial to the being under its conditions of life."[1] But apart from this fundamental and indeed inexcusable error, great difference of opinion exists to-day as to the real value of Darwin's theory. Some sturdy defenders still proclaim that it is the great and fundamental explanation of species; others—though they are few in number—hold that there is no substance in the theory and that those who believe in it believe in a vain thing. De Vries says: "Natural Selection acts as a sieve; it does not single out the best variations, but it simply destroys the larger number of those which are, from some cause or another, unfit for their present environment. In this way it keeps the strains up to the required standard, and in special circumstances may even improve them."[2] With that view probably the large majority of biologists would find themselves in sympathy, and would agree that Natural Selection is at least a potent agent, perhaps the most potent agent in evolution. But it is most important to understand its limitations, which have been very clearly pointed out by many and by none more clearly than by Driesch, to whose pages readers may be referred for a close analysis of the theory in question. He writes:[3] "It must be certain from the very beginning of analysis that

[1] "Origin of Species," etc., ed. vi., Vol. I, p. 99.
[2] "Darwin and Modern Science," Camb. Univ. Press, 1909, p. 63.
[3] "Science and Philosophy of the Organism," Vol. I, p. 262.

Natural Selection, as defined here, can only eliminate what cannot survive, what cannot stand the environment in the broadest sense, but that Natural Selection never is able to create diversities. It always acts negatively only, never positively. And therefore it can 'explain'—if you will allow me to make use of this ambiguous word—it can 'explain' only why certain types of organic specifications, imaginable *a priori*, do *not* actually exist, but it never explains at all the existence of the specifications of animal and vegetable forms that are actually found. In speaking of an 'explanation' of the origin of the living specific forms by Natural Selection one therefore confuses the sufficient reason for the non-existence of what there is not, with the sufficient reason for the existence of what there is. To say that a man has explained some organic character by Natural Selection is, in the words of Naegeli, the same as if someone who is asked the question, 'Why is this tree covered with these leaves?' were to answer, 'Because the gardener did not cut them away.' Of course, that would explain why there are no more leaves than those actually there, but it never would account for the existence and nature of the existing leaves as such. Or do we understand in the least why there are white bears in the Polar Regions if we are told that bears of other colours could not survive?"

One of the results which undoubtedly followed on the early and exaggerated acceptance of the doctrine of Natural Selection was a great distrust or even denial of what has long been known as the Argument from Design, which potent piece of logic was supposed to have been completely put out of action by the Darwinian broadsides. It is not too much to say that the assumption of a large part of the world of science, as shown by the writings, the correspondence and even the serious statements of the time, was that believers in anything higher than Nature, and more especially persons putting any faith in the argument from design, were objects if not of contempt at least of pity. Yet Lecky, when materialism was in its heyday, was telling its prophets that they were wholly wrong and that their theories made the postulation of a Creator more necessary if possible than

it had been before.[1] As Mivart pointed out at the time, Lecky says: "That matter is governed by mind, that the contrivances and elaborations of the universe are the products of intelligence, are propositions which are quite unshaken, whether we regard these contrivances as the results of a single momentary exercise of will, or of a slow, consistent, and regulated evolution. The proofs of a pervading and developing intelligence, and the proofs of a co-ordinating and combining intelligence, are both untouched, nor can any conceivable progress of science in this direction destroy them. If the famous suggestion, that all animal and vegetable life results from a single vital germ, and that all the different animals and plants now existent were developed by a natural process of evolution from that germ, were a demonstrated truth, we should still be able to point to the evidences of intelligence displayed in the measured and progressive development, in those exquisite forms so different from what blind chance could produce. . . . The argument from design would indeed be changed; it would require to be stated in a new form, but it would be fully as cogent as before. Indeed it is, perhaps, not too much to say, that the more fully this conception of universal evolution is grasped, the more firmly a scientific doctrine of Providence will be established, and the stronger will be the presumption of a future progress." These words are well worth quoting again and may be read in connection with the—also contemporary—parable of Charles Kingsley.[2]

Let us turn for a few moments to a consideration of the Argument from Design.[3]

The high-water mark of the Argument in pre-Darwinian days was certainly reached by a very remarkable though now much neglected book—Paley's Evidences, of which Darwin was a great admirer, claiming that at one time he could almost have repeated it by heart. Huxley also admired it, and pointed out that Paley had in many ways foreshadowed the evolution hypothesis and had declared

[1] In his "History of Rationalism," Vol. I, p. 316.

[2] See p. 337.

[3] I may refer readers to my volume "A Century of Scientific Thought and other Essays," Burns and Oates, 1915, for a further discussion of this matter. Part of this chapter is extracted from the essay in that book.

that when properly understood it was not really in opposition to religion.

Paley starts with the famous simile of a watch found by a traveller on a heath who recognises at once that it is quite a different thing from the stones which he has hitherto encountered on his way. It is, he claims, an inevitable inference that the watch must have had a maker, " an artificer or artificers, who formed it for the purpose which we find it actually to answer: who comprehended its construction, and designed its use." Nor, in his opinion, are the arguments weakened by the facts that: First we may never have seen a watch made, or known an artist capable of making one; second, that the watch, sometimes, even frequently went wrong; third, that there were parts in it which we did not understand. Further, he argued that the finder of the watch could not be expected to be satisfied by any of the following arguments: First, that it was one of many combinations of matter, and might have been thus or otherwise arranged; second, " that there was a principle of order which had disposed the parts of the watch into their present form and situation "; third, that the mechanism was not proof of contrivance, only a motive to induce the mind to think so; nor again by the argument that, fourth, the watch was no more than the result of the laws of metallic nature. Finally, he is not to be put off from his belief by being told that he knew nothing of the matter. It will be observed that in this parable Paley sums up all the lines of argument which had been brought forward, or indeed have since been brought forward or could well be brought forward in favour of a materialistic explanation of Nature. Having given his parable, he proceeds in great detail to apply his argument to various contrivances throughout the animal kingdom. Thus he examines the eye and its mechanism, and claims that if it presents lenses and a focussing apparatus and other things of the kind just as a telescope does, then, just as the telescope must have had an intelligent maker who constructed it for the purpose for which it is fitted, so also must the eye have had its intelligent artificer.

Now the remarkable thing is that Darwin and almost

all his contemporaries seemed to be quite sure that Natural Selection had utterly and for ever overthrown the argument from design. Darwin himself wrote: "The old argument from design in nature, as given by Paley, which formerly seemed to me so conclusive, fails, now that the law of Natural Selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings, and in the action of Natural Selection, than in the course which the wind blows."[1] It is certainly a bold and also certainly a wholly unwarrantable demand upon our belief that the doctrine of Natural Selection was thus powerful, and it ignores the fact that a powerful agent of its kind can only have come into being in one of two ways—by chance or by design. If the former, we have to believe that by accident the particles of matter in the universe formed a world, by accident also, and, in some manner hitherto undreamt of by the modern chemist, that the seed of life appeared on this accidentally constructed world. Then, by pure, blind, blundering chance, the law of Natural Selection came into effect and by its action produces all living things, including the brain and genius of man and every work of genius and imagination that man has ever produced. The man who can believe this has certainly an enviable power of imagination and credulity.

Surely it must be obvious—indeed it is admitted by even materialistic men of science—that a Law presupposes, indeed compels, a belief in a Law-giver. We may say that we know nothing of Him—that is the pure Agnostic attitude—but we shall find it difficult to dispute the existence of such a Being if once we admit the Law. It is once more the case of the Being who makes things make themselves. Certainly it does not give us a less exalted idea of the Creator if, to take up Paley's parable once more, we look again at the watch and consider that its artificer had not made it himself but had so empowered things of his creation

[1] "Life and Letters of Charles Darwin," Vo . I, p. 309.

that they could themselves make it and many another wonderful work. These, under this hypothesis, would be as much the product of His idea as if He had indeed called them fully made out of nothing by immediate creation. Thus, as Lecky told the men of his time, the doctrine of the Argument from Design emerges from the struggle stronger than it ever was, irrefutable indeed unless we are to believe in Blind Chance, or to deny our own intellect and attempt to hold that there may be a Law without a Law-giver.

There is a further matter in connection with Natural Selection which must not completely escape notice. If Natural Selection is a law of Nature, and, if, as some would have us believe, there is no higher law by which our actions should be governed, ordinary logic would seem to suggest that we should do our best to assist the law of Natural Selection and not to thwart them, as Charity, working on the lines indicated by Christianity, is constantly endeavouring to do. Why should we not assist Natural by Artificial Selection and arrange the matrimonial affairs of budding youth according to the methods of the stud-farm? Something like this is the programme of the more advanced Eugenists, and something like this has been proposed as an ideal to be sought after, by a recent President of the British Association in his presidential address.[1] There is one element in the calculation which seems always to be omitted by the visionaries who are the parents of schemes such as this: Human Nature, which, especially as manifest in the young, is very unlikely to submit to its matrimonial arrangements being made for it by a jury of matrons and doctors and wholly without regard to such trifles as love and mutual attraction. We need have no serious fears so far as this proposition is concerned. One wonders, however, whether those who refuse to believe in any higher law than that of Nature, have ever thought out what would follow upon a strict adherence to natural laws and what sort of a world to live in would be one bereft of God, conducted in strict conformity with Nature as we see it around

[1] Bateson, Part II of Address, delivered at Sydney.

us "red in tooth and claw." It is all very well to talk of the Survival of the Fittest in the Struggle for Existence, but, if we invert the meaning, we may arrive at a better comprehension of what it entails. The Survival of the Fittest means the Extermination of the Less Fit. What would this mean in the case of mankind? Rigid extermination of the feeble and unfit: the cripples, the sickly, and suchlike, must wend their way to the lethal chamber for the benefit of the race, or must at least be incarcerated so as to cut them off from any prospect of propagating offspring like unto themselves. Carried a step further, even the stupid and the less active in body must be eliminated or restrained, so that the race may become greater and more powerful. So much for the inner life of the nation, but what of the outer? The more powerful nation is to wipe out the weaker without any pity: why should there be any pity when it is the Law of Nature that the Strong shall inherit the Earth and that Might is Right? Let any person consider even for a few moments what a world conducted on the lines of Natural Selection, unchastened by any ameliorating influences of a religious character, would be: he will not be long in coming to a conclusion that hell itself could scarcely be a less comfortable place to live in. It is perfectly true that neither Darwin—one of the kindliest of men, as we learn from his life—nor his almost equally kind-hearted followers for an instant contemplated such infamies as those which have been suggested above. But when we are told that Christianity is an exploded thing and that we must decline upon the laws of Nature, it is well to consider what that is likely to lead us to. Morality, as we understand it, is not to be learned from the laws of Nature, nor the natural operations of the living world. This fact alone ought to be enough to teach any rational human being that there must be something higher than Nature and the teachings of Nature; since to trust merely to the laws of Nature is to enter at once a lupanar and a slaughter-house.

Nor is it of any use to argue that the prophets of the Gospel of Nature are not themselves brutal or uncharitable, nor to urge that they are supporters of hospitals and other

good works of the kind. In that they are so they are belying their own principles, for Nature teaches no such doctrine, provides no hospitals for the sick and wounded but rather a speedy death. It is the atmosphere of the Gospel of Christ in which such persons live and in which they have been brought up which, perhaps insensibly, influences them, and not the Gospel of Nature of which they proclaim themselves adherents.

CHAPTER XXXV

DOUBTS AS TO DARWINISM—MENDEL AND HIS DISCOVERIES

IN his Presidential Address to the British Association in 1913, Sir Oliver Lodge spoke of the characteristic (so far as pure science was concerned), " of the promising though perturbing period in which we live " as being " rapid progress, combined with fundamental scepticism." He further told us that " a critical examination of scientific foundations " was going on, and that " a kind of philosophic scepticism " was in the ascendant, " resulting in a mistrust of purely intellectual processes and in a recognition of the limited scope of science."[1] His successor, Professor Bateson, looking at things from the standpoint of a biologist, delivers himself in very much the same strain. " My predecessor," he says, " said last year that in physics the age is one of rapid progress and profound scepticism. In at least as high a degree this is true of Biology, and as a chief characteristic of modern evolutionary thought we must confess also to a deep but irksome humility in presence of great vital problems."[2]

We have seen in the last chapter that great doubts have been expressed as to the value of Natural Selection by many biologists, and by none more so than the author of the address in question, which may be quoted as the latest and most magistral utterance on the subject. " We have come to the conviction that the principle of Natural Selection cannot have been the chief factor in delimiting the

[1] " Continuity," Dent, London, 1913, pp. 7, 11.
[2] Bateson, " Presidential Address to British Association," Part I, Melbourne, p. 9.

species of animals and plants such as we now, with fuller knowledge, see them actually to be. We are even more sceptical as to the validity of that appeal to changes in the conditions of life as direct causes of modification, upon which latterly at all events Darwin laid much emphasis" (*ibid.* p. 2). "We go to Darwin for his incomparable collection of facts. We would fain emulate his scholarship, his width and his power of exposition, but to us he speaks no more with philosophical authority. We read his scheme of Evolution as we would those of Lucretius or Lamarck, delighting in their simplicity and their courage" (*ibid.* p. 8). And the outcome of all this: "We are just about where Boyle was in the seventeenth century. We can dispose of Alchemy, but we cannot make more than a quasi-chemistry. We are awaiting our Priestley and our Mendeléef" (*ibid.* p. 19).[1]

It is not merely as to Natural Selection that doubt is expressed, but as to other incidental portions of Darwin's teaching. We have seen that this was the case as to Pangenesis, and it certainly is with regard to his views as to the cumulative value of small variations: for Darwin taught that it was in this way that the origin of species came about. It is true that at times he wavered towards the view that larger changes—saltations or mutations as they are now called—might stand for something in evolution, but on the whole he was unfavourable to this view—less favourable indeed than Huxley, who expressed the opinion that Darwin had tied his own hands by too vigorous a profession of faith in the formula *Natura non facit saltum.* Nothing can now be more sure than that Nature does make

[1] The reader who is unfamiliar with the stream of biological literature, may be warned that the above views are those of one school and one school only of biological workers. Diametrically opposite views are held by other and equally distinguished bio ogists; those who desire to study these in a readable form may be referred to Poulton, "Darwin and the 'Origin,'" London, Longmans, 1909; Ray Lankester, "The Kingdom of Man," London, Constable, 1907. It may be added that the confident language of the address in relation to the all-powerfulness of Mendelism as a future explanation of biological problems is the echo of the similar hopes expressed as to Darwinism some forty years ago. It may quite well be re-echoed forty years hence by some President of the same Association, proclaiming the partial failure of Mendelism and extolling the coming conquest of the scientific world by the fashionable theory of the day.

leaps, and whether we accept the statements of de Vries[1] to the full extent or not, it may safely be said that the general opinion of biologists is entirely against the possibility of any process of evolution having taken place by means of small, slowly accumulating variations. It is at any rate obvious that when we look out upon Nature we see not a continuous but a discontinuous picture. Further, we now know or think we know—on this point, indeed, we have perhaps attained to greater certainty than mere thinking—that the series-scheme so dear to the hearts of phylogenists, is a delusion; there is no evidence that the various forms which can be fitted so beautifully into a series were ever terms of any such series. "Presented with a collection of modern Sweet Peas, how prettily would the devotees of Continuity have arranged them in a graduated series, showing how every intergrade could be found, passing from the full colour of the wild Sicilian species in one direction to white, in the other to the deep purple of 'Black Prince,' though happily we know these two to be among the earliest to have appeared."[2] Here is a case in which we know that the arrangement in series which a phylogenist most certainly would have made would have been wholly incorrect. We have the same information as to other similar and apparently attractive phylogenetic arrangements: how are we to know that many, perhaps all, of the other series which have been unfolded for us are not equally fallacious? Take that commonplace of the text-book, the favourite example of the small manuals of Evolution, the pedigree of the horse, proclaimed in one of them[3] as "a conclusive instance." Doubts had long ago been expressed as to this series, and caution inculcated, by Sedgwick in his well-known text-book of Zoology. Is it not clear now that there is some, perhaps much reason to suppose that this much-lauded series is not a phylogenetic series at all; not monophyletic but polyphyletic? The whole teaching of the wing of biologists represented by Professor Bateson is in favour of a polyphyletic origin of species—a view in which Father

[1] In his "Species and Varieties," Chicago, 1905.
[2] Bateson, i., p. 15.
[3] Saleeby, "Organic Evolution," London, Jack.

Wasmann, a biologist of great distinction, poles apart from Bateson in other directions, concurs.[1]

Then again it is more than doubtful whether any new characteristics can be added in the process of evolution. It has been pointed out that most mutations with which we are acquainted are due to losses of one or perhaps even more than one, of the characters of the wild type. De Vries calls these "retrogressive mutations," and they appear to follow the Mendelian laws of heredity, of which more has to be said. It is obvious that a thornless rose would be a different thing from the rose of the hedges, but the difference would be caused by the loss of something—in this case the thorns—and not by the addition of any new feature. But surely new features *do* appear? They certainly seem to do so, but according to the authorities on Mendel, they are not really *new* qualities in any proper sense of the word. They are qualities which have all the time been there, but have been "inhibited," as it is called, by other qualities, which have prevented them from coming to the front. Two or three boys may pass wholly unnoticed in a school because they are downtrodden and made to keep in the background by bullies: on the departure of the latter, the hitherto neglected boys may take a prominent place in the politics of their school. In like manner characteristics latent in living things are thrust into the background by other factors: if these factors happen to be eliminated, the hidden things are made plain. But it must be noted that this is not the case of a gain. On the contrary, the transaction which appears to end in a gain is really a loss, for until the restraining qualities have been removed and thus lost the hidden qualities cannot appear.

Finally, after a careful study of the vast field of experiment on Mendelian lines which has marked the years since Abbot Mendel's discovery was rediscovered, Lotsy has answered, in the negative, the question as to whether there is any such thing as spontaneous variation. In his opinion, all that we call variation is really due to the crossing of well-marked varieties. Truly it is not wonderful if the searcher

[1] See p. 339.

of biological literature of to-day, in unison, so one gathers, with the physicists, should exclaim in his despair, " All that I know is that nothing can be known."[1]

It is now time to turn to the consideration of the real disturbing element in all this *volte-face* as to Darwinism. That it is not a universal *volte-face* has already been admitted and emphasised. What has caused the partial alteration of opinion to which we have been calling attention ? We have already seen that the discovery of radium at once produced an extraordinary bouleversement of views in the physical wing of science. The discoveries of Abbot Mendel have not been as all-powerful as yet, since their significance is still disputed by very competent critics ; but they have assuredly worked a very remarkable change in scientific opinion during the short time that they have really been before the world. Mendel was an Augustinian monk and ended his days as Abbot of Brünn. Prior to his election to that position, the occupations of which most unfortunately put an end to his scientific discoveries, he devoted a great deal of attention to experiments in connection with inheritance. Unfortunately he buried these researches in the archives of a local natural history society and they attracted little if any attention, greatly to their author's chagrin, but with no reduction in his confidence as to their ultimate success. Mendel's papers were read to the society in Brünn in the years 1865 and 1869. It will be remembered that the " Origin of Species " appeared in 1859, some years before the publication of Mendel's papers. It is curious but seems nevertheless to be a fact that Darwin never heard of Mendel's work.

It has often been speculated as to the effect that Mendelian discoveries might have had upon Darwin's views. Mendel died in 1884, and his discoveries seemed to be buried, with many a score of others, under the ever-accumulating cairn of scientific papers. It was not until 1900 that three

[1] After proclaiming his doubts as to biology, the writer of the address in question does not hesitate to build on our foundation of ignorance some of those political theories which were alluded to in chapter xxxiv, and to deal in those onslaughts on " superstition " and " mysticism " which we have been accustomed to hear for these fifty years past from the upholders of totally different theories.

scientific workers, de Vries being one of them, called the attention of biologists to his long-forgotten works. Since that date the number of papers which have appeared on the Mendelian theory and the experiments which have been made in connection therewith have been alike almost countless; and it may safely be said that the discoveries of the Augustinian Abbot have caused as much ferment in the scientific world as those of Darwin did at the time of their appearance. Like Darwin's theories, those of Mendel have been acclaimed by their supporters as being the last possible word of science on the subject and as a solid foundation of ideas not merely biological but political. It will, therefore, be well to give some brief account of the theories themselves and of certain important deductions in connection with them.[1]

Mendel's experiments were made largely but by no means exclusively on peas, but since his death they have been applied to all sorts of forms, vegetable and animal. In the last analysis his method depends upon the segregation of characters, not individuals. For example, peas may be tall or dwarfish, their seeds may be smooth or wrinkled, green or yellowish, and so on. Mendel, by careful study, directed to single characters, such as the above, arrived at certain conclusions which form the so-called Mendelian laws.[2] Let us take the best-known example perhaps of his theory, that of the tall and short peas. Mendel took two varieties of peas, which he had already found to breed true, as regards height. The normal height of one was six feet (tall), and of the other, one and a half (dwarf). These two strains were crossed with one another, sometimes the pollen of the tall being used, sometimes that of the dwarf. The

[1] The subject of Mendelism has developed an enormous literature and a most complicated technical terminology. The classical work on the subject is that by Bateson, "Mendel's Principles of Heredity," Camb. Univ. Press, 1909, which contains a translation of the two original papers. A good account of a less technical character will be found in Lock's interesting book "Recent Progress in the Study of Variation, Heredity and Evolution," London, John Murray, 1906. A short sketch of Mendel's life and work will be found in "Twelve Catholic Men of Science," published by the Catholic Truth Society, 1912.

[2] I give these as I gave them in my "Facts and Theories," p. 153, as that explanation was made as simple and as complete as possible.

results were the same in both cases. In all cases the result was that the offspring were all "talls," some of them even taller than the parent "tall." Mendel, therefore, called "tallness," in this instance, the *dominant*, and "dwarfishness" the *recessive* character. It might have been thought by the hasty observer that dwarfishness had been wiped out, but what was the result of the sowing of the seeds of the self-fertilised hybrids? A mixed generation consisting of "talls" and "dwarfs," but—most significant fact—of *no* intermediate forms. Further, it was found that the "talls" were to the "dwarfs" as three is to one. The seeds from this second hybrid generation were also saved, those from each individual plant being carefully harvested and separately sown. What was the result? The seeds of the "dwarf" recessives bred perfectly true, none but "dwarfs" resulting.

But not so the "talls." Some of these bred true, producing only "talls," but some of them acted like the first hybrid generation of "talls," and produced a generation of "talls" and "dwarfs" in the proportion of three of the former to one of the latter. Further experiments with other pairs of characteristics such as yellow and green colour, led Mendel to lay down the law that "in every case where the inheritance of an alternative pair of characters was concerned, the effect of the cross in successive generations was to produce three, and only three, different sorts of individuals, viz. dominants which bred true, dominants which gave both dominant and recessive offspring in the ratio of three to one, and recessives which always bred true." What happens in the case of the true-breeding forms appears to be that the opposite factor, of whatever kind that may be, has become eliminated.

The supporters of the Mendelian law make great claims for it, urging that it is on a level with the discoveries of Newton and that it has been found applicable to all kinds of characters, mental as well as physical. In considering these claims and assertions the wise will remember the chorus of approval from scientific men which welcomed the "Law" of Natural Selection and the gradual waning of that theory, and will "wait and see" before they come to

look upon Mendel as the discoverer of the key to all biological riddles. This, however, can and should be said; that, as to the truth of the Mendelian law in certain cases at least it seems as if there can be no doubt. Its opponents, I think, admit this, but they claim that its applicability is not universal, wherein they may or may not be right. Time alone can show the result of long-continued experiment.

Meantime this at least may be said that in common with other Laws of Nature it compels us to recognise a Law-giver. This is even admitted by so firm a monist as Plate.[1] Plate says we can know nothing of this Law-giver—his own independent opinion—but the main point is that he admits that if there is a Law there must be a source for that Law in the shape of a Law-giver. One would have thought that this was a self-evident proposition, but it is not so to some minds. There is a curious passage in the writings of one of the greatest Mendelians of the day—indeed the leader of that body—to which I have elsewhere called attention. He says that " with the experimental proof that variation consists largely in the unpacking and repacking of an original complexity, it is not so certain as we might like to think that the order of these events is not predetermined."[2] It is a little difficult to understand why " we " should not like to think that things were predetermined. Science is supposed to direct its attention to the elucidation of facts, and above all things to be entirely unbiassed by any *parti pris* in her judgments.

Father Wasmann says in one of his books[3] that " in many scientific circles there is an absolute *theophobia*, a dread of the Creator," which he regrets because he believes " that it is due chiefly to a defective knowledge of Christian philosophy and theology." Therein most people with any knowledge of these subjects will agree with the learned Jesuit. If there be a Predeterminer and a Law-giver, and

[1] See his admissions in the discussion between himself and others on the materialistic side and Wasmann for the opposite in Wasmann's " Problem of Evolution," London, Kegan Paul, 1909. The passage in question will be found on p. 108.

[2] Bateson in " Darwin and Modern Science," p. 101.

[3] " Problem of Evolution," p. 47.

if, as Christians believe, He is the God in whom we place our trust, it is not easy to understand why "we" should not like to think of Him, and why it should be regarded as rather in the nature of an insult to suggest that Science points Him out to us in the most unmistakable manner.

CHAPTER XXXVI

TRANSFORMISM—A SUMMING UP

IN this chapter we shall attempt to sum up the conclusions which we are entitled to come to respecting the evolutionary theories of to-day and their relation—so direfully misunderstood in the past—to religious dogma.

i. We must keep before our minds the fact that transformism, however probable it may seem, is not by any means a proved fact. Perhaps it never will be proved: perhaps it is insusceptible of proof: at any rate, it remains unproved to-day, and this in spite of the absurdly confident statements of primers and small manuals never tired of proclaiming that transformism is as much a certitude of science as gravitation. It is quite certain that the overwhelming majority of biologists accept transformism as the solution of the question of species and their origin. Here and there a voice, like that of Fleischmann, cries out against it, but it cannot be said that such utterances have any effect upon scientific opinion, though they lead men careful of science to admit the unproved character of the evolutionary hypothesis. Thus Professor T. H. Morgan, whilst differing from Fleischmann and admitting that his views have had little if any effect in weakening the belief of the biological world in the truth of evolution, adds: "He has done, nevertheless, good service in recalling the fact that, however probable the theory [of evolution] may appear, the evidence is indirect and exact proof is still wanting."[1]

In connection with the point now under consideration and the probable impossibility of arriving at any time at what could with any accuracy be described as a proof of evolu-

[1] In his most interesting and suggestive book, "Evolution and Adaptation," Macmillan Co., New York, 1903, p. 57.

tion, the following passage from one of Wasmann's works is much to the point. The doctrine of evolution, he points out, is "not an experimental science and can never be one. It is essentially a theory based upon a group of hypotheses which are in harmony with one another, and afford the most probable explanation of the origin of organic species. We cannot demand to see the evolution of species taking place before our eyes, in such a way as to give us a direct confirmation of the theory of evolution. Man was born far too late, and lives far too short a time, to be able to make such a demand. Imagine a fly, destined to live but one day, which comes to life one beautiful morning in spring, and sees all around it the trees in full blossom. That the blossoms came forth from buds which gradually unfolded, and that the blossoms in their turn will lose their petals and develop into fruit, all this must remain hidden from the fly during its few hours of life. It might therefore be tempted to believe that the blossoms all around were created by the good God exactly as it sees them, and will remain unchanged for ever. The fly would be greatly mistaken, and even as an ephemeral fly, if it had intelligence, it might perceive some slight signs that the splendour of the blossoms was not unchanging. It might see that, in the course of a few hours, some buds had already opened more fully, some blossoms had lost their petals either partially or wholly. The opening buds are those rare traces of modification of species which we can still prove to have taken place, although within comparatively narrow limits. If we continue the simile, the falling petals are the species in process of extinction, and the fallen leaves are the extinct species known to us only as fossils, which reveal to us the fate of all organic species on earth: they come and go and give place to their successors, and though the duration of their existence may be reckoned in thousands or even millions of years—as is that of many kinds of the brachiopod genus *Lingula*—yet for them, as for each one of us, there is a beginning and an end."[1]

Fr. Wasmann from his long and fruitful study of ants and their inquilines, comes to the conclusion that "the

[1] "Problem of Evolution," p. 6.

principle of the theory of evolution is the only one which supplies us with a natural explanation" of the phenomena in question, for which reason he accepts it "as far as its application is supported by actual proofs."[1] To this conclusion the present writer has no hesitation in subscribing and believes that it would meet with acceptance from most scientific biologists.

ii. We must further remember that some of the arguments which at first seemed most potently to support the theory of transformism have now broken down, either completely or in part. For example, the phylogenetic argument which arranges plants and animals in beautiful series on the assumption that a genealogical tree can be constructed for them, as it can for some royal or noble family whose ancestry and connections are set down in the Almanach de Gotha, seems to have completely broken down in face of the facts brought to light by Mendel and his followers, and briefly recapitulated in the preceding chapter. Driesch does not hesitate to speak of the "phantasy christened Phylogeny." After having pointed that "the gallery of ancestors" which Liebmann said was all that phylogeny provides us with, was not even reliable, he proceeds: "Far more eloquent than any amount of polemics is the fact that vertebrates, for instance, have already been 'proved' to be descended from, firstly, the amphioxus; secondly, the annelids; thirdly, the *Sagitta* type of worms; fourthly, from spiders; fifthly, from *Limulus*, a group of crayfishes; and sixthly, from echinoderm larvae. That is the extent of *my* acquaintance with the literature, with which I do not pretend to be specially familiar. Emil du Bois-Reymond said once that phylogeny of this sort is of about as much scientific value as are the pedigrees of the heroes of Homer, and I think we may fully endorse his opinion on this point."[2]

Then again there is the recapitulation argument, which taught that the history of the individual represented or reproduced that of the race. It too is badly damaged by Mendelian principles and, apart from that, is abandoned by

[1] *Op. cit.*, p. 14.

[2] The first quotation is from "History and Science of Vitalism," p. 140, the second from "The Science and Philosophy of the Organism," Vol. I, p. 256.

others such as Kellogg, who says it "is chiefly conspicuous now as a skeleton on which to hang innumerable exceptions," and that "the recapitulation theory is mostly wrong; and what is right in it is mostly so covered up by the wrong part, that few biologists longer have any confidence in discovering the right."[1] No doubt other biologists take up a diametrically opposite position, but there is no denying that the theory in question does not occupy the strong position which it seemed to do during the years immediately succeeding its first promulgation by Haeckel and Fritz Müller.

iii. It is now perfectly clear that, whatever may or may not be its value, Natural Selection is in no sense the full explanation of and justification for a transformist theory that it was at first claimed to be. On this head sufficient has already been said.

iv. Mendelism does not offer any very special support to the transformist theory as commonly understood—indeed it suggests this difficulty, that whilst evolution would seem to assume an ascent from simplicity to complexity, Mendelism exhibits nature in the constant process of shedding characters and thus proceeding from a greater to a less complexity.

Such at least would seem to be the teaching given us by those who insist that even those characters which appear to be new in a variety or in an individual are not really so, were there all the time *in petto*—"stopped down," so to speak, by other and stronger characteristics, the removal of which has permitted the appearance of those which up to that time had been hidden. Professor Bateson discusses this point in the address from which quotation was made in the last chapter, and admits that it "involves a certain effort" to "reverse our habitual modes of thought" and ask ourselves whether "we are limited to the old view that evolutionary progress is from the simple to the complex, and whether after all it is conceivable that the process was the other way about."[2] And all this because, for other

[1] "Darwinism To-Day," London, George Bell & Sons, 1907, pp. 18 and 21.

[2] British Association Address, 1914, I, pp. 15, 16.

reasons of course, "we have got to recognise that there has been an evolution, that somehow or other the forms of life have risen from fewer forms." It is evident that we are as far away from the explanation of the mechanism of evolution as we were in pre-Darwinian days.

v. We get no certain teaching as to whether that was monophyletic or polyphyletic. Darwin, as we have already seen, was himself somewhat doubtful on this point,[1] but it is certainly true that whilst a monophyletic commencement of evolution was not exactly *de fide* amongst faithful Darwinians it would for a time at least have been decidedly daring to doubt it. Yesterday it was generally believed that life started from a single source ; to-day many would agree that there were several such sources.

Wasmann[2] says that "the assumption of a monophyletic evolution of the whole kingdom of organic life is a delightful dream without any scientific support," and that "the same may be said of the assumed monophyletic evolution of the whole animal kingdom on the one hand, and of the whole vegetable kingdom on the other, from one primary form respectively." Of course, it may be argued that Wasmann is not only a believer in religion but a Jesuit, and one must therefore discount his opinion heavily. But he has witnesses not thus discredited. Fleischmann, for example, says that it is impossible to trace back the chief types of the animal kingdom to one primitive form. Yes, but Fleischmann is an opponent of evolution and therefore biassed. Of course everybody is biassed who does not shout with the largest crowd, but what about Oscar Hertwig, who is certainly untainted with any of the suspicious qualities of the two writers last quoted? Hertwig is thus quoted by Wasmann: "Evidence of the monophyletic development of different races is altogether wanting, and we are forced more and more to accept the theory of development from a variety of stocks." Further, he states that Boveri, and a number of other zoologists, botanists and palæontologists[3] hold the same view. Finally, Bateson,[4] who certainly has no theo-

[1] See p. 336.
[2] "Problem of Evolution," p. 15.
[3] For whom see "Problem of Evolution," p. 16.
[4] Address, I, p. 18.

logical taint, and who is a stout supporter of the general theory of evolution, says: "We should be greatly helped by some indication as to whether the origin of life has been single or multiple. Modern opinion is, perhaps, inclining to the multiple theory, but we have no real evidence."

It ought not to be forgotten that it was Bateson who in the great work which first caused a rift in the strict Darwinian phalanx,[1] set at the head of his Introduction the pregnant text "All flesh is not the same flesh: but there is one kind of flesh of men, another flesh of beasts, another of fishes, and another of birds."

vi. The remarkable facts connected with what is called "convergence" are quite unexplained by Darwinian views but receive or may receive an explanation in terms of polyphyletic evolution. Some brief account of what is meant by this term may here be given, since the subject is one of great intrinsic interest, apart altogether from its bearing on the point with which we are now concerned.[2]

Convergence is a term applied "to resemblances amongst animals which are not due to direct relationship or genetic affinity; in other words, which are not derived by inheritance from common ancestors, but which result from independent functional adaptation to similar ends."[3] Everybody knows that the hedgehog and the porcupine are both of them covered with spines, yet the first is an insectivore and the last a rodent, races widely separated from one another. There are two kinds of flying fish—*Exocetus*, which is a herring-like form, and *Dactylopterus*, which is a gurnard. These belong to different families, yet both of them can pursue a limited flight in the air and both of them owe this power to the fact that their pectoral fins are elongated and expanded—a remarkable modification which cannot be explained by any relationship between the two creatures.

Here is another and more remarkable example. Most persons will be aware that mammalia are divided into

[1] "Materials for the Study of Variation Treated with Special Regard to Discontinuity in the Origin of Species," London, Macmillan, 1894.

[2] For a careful and most interesting study of this subject the reader may be referred to "Convergence in Evolution," by A. Willey, London, Murray, 1911.

[3] *Op. cit.*, p. 52.

non-placental and placental divisions, the former having a much narrower range of habitat than the latter, which are all over the world. On the old theory of phylogeny both of these were thought of as arising from a common form which dichotomised into the two great divisions. On this theory it is certainly difficult to explain the curious series of resemblances in habit and adaptation to which Mr. Willey draws attention in his book and which may thus be tabulated :

Non-Placentals.	*Habit.*	*Placentals.*
Dasyurinae	Carnivorous	Carnivora
Myrmecobineae	Ant-eating	Myrmecophagidae
Petaurus	Flying	Pteromys
Chironectes	Swimming	Lutra
Peramelidae	Burrowing (Large-eyed forms)	Muridae
Notoryctidae	Burrowing (Small-eyed forms)	Talpidae

vii. It has been claimed that a belief in evolution under any shape or form necessarily goes with a monistic view of the universe, by which is meant that form of monism which excludes all idea of a Creator. It has already been shown that this is absurd, for all really instructed teachers of a Transformist doctrine from Darwin onwards have been insistent in their teaching that evolution does not account for the beginning of things and makes no pretension to do so. We must invoke some explanation, unless, with Huxley and others, we are prepared for a perpetual confession of ignorance : and we have seen that it is not only believers in Christianity or in a religion of some kind who have come to the conclusion that the theory of a Creator is that which best explains things as they are. Once for all, then, it may be said that the statement that monism logically follows upon Darwinism is not correct. Indeed it is difficult to see how those who are so insistent on the fact that there are laws of Nature which accomplish ingenious ends, can account for them without postulating a Law-maker as the originator of what must otherwise be assumed to be the work of blind chance.

viii. We have seen that some sort of evolution—any of the forms discussed in the preceding pages—if looked upon as a method of creation is not antagonistic to the teaching of the highest doctrinal authorities in the Catholic Church, such as St. Augustine, St. Thomas Aquinas, Suarez and others (see Chapter XXXII). On this point I may conclude with two quotations from Father Wasmann—who is far better qualified to speak on this particular point than the present writer—since they not only show his own views but also illustrate the further point which has been several times urged in these pages—namely, that the mediate scheme of Creation gives us an even more exalted idea of the greatness of the Creator than would be given by an immediate form. "Personally," he writes,[1] "I am firmly convinced that the doctrine of evolution, considered as a scientific hypothesis and theory, is not at variance with the Christian theory of life, although the contrary is often asserted. . . . If we assume that God is the Creator of all things, and that the world created by Him has evolved independently and automatically, we have actually a greater idea of God than if we regard Him as constantly interfering with the working of the Laws of Nature. Let us imagine two billiard players, each having a hundred balls to direct. The one needs a hundred strokes in order to accomplish his end; the other with one stroke sets all the balls in motion, as he will: the latter is undoubtedly the more skilful player. St. Thomas Aquinas stated long ago that the force of any cause was the greater, the further its action extended. God does not interfere directly in the natural order where He can work through natural causes. This is by no means a new principle, but a very old one, and it shows us that the theory of evolution, as a scientific hypothesis and theory, as far as it can be really proved, is perfectly compatible with the Christian theory of the origin of things. According to this view, the evolution of the organic world is but a little line in the millions of pages contained in the book of the evolution of the whole universe, on the title-page of which still stands written in indelible letters: 'In the beginning God created Heaven and Earth.'"

[1] "Problem of Evolution," p. 18.

ix. Finally, it may be pointed out once more that, for Catholics at least, a number of difficulties of a minor character seem to be completely overcome by ever bearing in mind the teaching of our philosophy and theology as to the "nowness" of God. The laws, whatever they may be, discovered or undiscovered, are His laws, and were made operative at the moment (we are obliged to speak in the inadequate words of time and space) that creation took place. The whole scheme was one and complete at that moment, and we have no more need to think, in the ordinary significance of the words, of "interferences" than we have to consider it an "interference" when a clock strikes twelve. When the clock was made, it was intended to strike twelve at the appropriate moment: when creation was launched on its course it was equally intended that fishes should appear at a certain moment and man at another. But all were, in idea, created at the same instant, which with the Creator has always been and always will be "Now."

CHAPTER XXXVII

MAN AND HIS ORIGIN—HIS BODILY PART

WE are now approaching the termination of our enquiry. Having dealt with the question of transformism as it applies to the lower creation we must now turn our attention to man. Is there any real distinction between the case of man and that of other living things, particularly other mammalia, to which order he belongs anatomically? Yesterday, so to speak, a large portion of the scientific world would have replied that there was no distinction, bodily or mental, save one of degree; to-day the reply would hardly be so confident nor so unanimous.

For us Catholics there can, of course, be but one reply that, whatever may be the case with regard to man's bodily attributes, which form the topic of this chapter, there can be no question as to his soul, which we shall consider in the next.

We believe that the soul of man is a wholly different thing from the "souls" of lower animals. Aristotle came to this conclusion by pure reason and without the aid of revelation. Our psychologists of to-day seem to be reaching it again—by devious paths no doubt, but still reaching it—as we shall see when that part of our subject comes under consideration.

From the account of the creation of the world given in Genesis one fact emerges with great clearness. The creation of man was a dual event and is so described, whereas the creation of all other things is, in each case, described as a single event. Cardinal Newman emphasised this distinction in one of his sermons: "Man was made rational after he was made corporeal. 'The Lord God formed man of the dust of the ground, and breathed into his nostrils the breath

of life, and man *became* a living soul' (Gen. ii. 7). Here are two acts on the part of the Creator—the forming the dust and the breathing the life."[1]

According then to what would seem the natural meaning of the words of the Bible, it would appear that the Creator first made a suitable habitation for the soul, and when that habitation was made, infused the soul into it, when and when only it became what can properly be called "Man." There would thus, according to the language of the text, seem to have been a time, however brief, when there was a man-like organism which was not yet man. It is to be noted that in the account of the creation of other living things, no such distinction is made as to a twofold operation. From this we may be led to suppose that the creature and its vital principle did not in these cases result from separate acts of the Creator.

Let us now consider the body, the habitation of the soul.

Unquestionably man's body closely resembles the body of other mammals and especially that of the ape; indeed, anatomically, he is an ape: even the anatomy of his brain presents great similarity to that of the higher apes. As we have yet to see, the more this particular point is pressed, the stronger becomes the psychological argument resting upon the mental differences between the two.

This great anatomical similarity between man and other mammals certainly strongly suggests a common physical origin. It is not in itself a proof of such; indeed there is no conclusive evidence at present in existence for this theory. Nevertheless the supposition of the common origin of the body of man and of other mammals may be used and is used by science as a working hypothesis to deal with the morphological problems which arise in terms of that hypothesis—as was the theory of Copernicus when first put forward by him. It may then be found that an increasing number of these morphological problems and what appear to be their solutions, point in the direction of the working

[1] "Sermons Bearing on Subjects of the Day," 1869, Sermon VII, p. 101.

hypothesis thus adopted. This would gradually augment its probability and indeed make it more of a fact to us and less of a hypothesis. But it must not be forgotten that an opposite result has occurred in the case of many working hypotheses and may do in connection with this.

We must always keep clearly before our minds that very important truth which has been so often—but not too often—insisted upon in this book—namely, that because an explanation explains all the terms of the thing to be explained, it is not, therefore, necessarily the true explanation but may be far removed from it.

Scientific investigators may, in this way, be on the track of the true explanation of the origin of man's body or they may not. Of only one thing can we feel absolutely sure, and that is that down to the present moment science has arrived at no *conclusive* proof of the common origin. "The only statement, consistent with her dignity, that science can make, is to say that she knows nothing about the origin of man." So wrote Reinke in 1902,[1] and so must any honest biologist write to-day, for no discovery has since been made which affords unquestionable evidence for the opposite statement.

We have already seen that man, as we first know of him, was skeletally identical with man as he now exists; that he was a skilful toolmaker in stone, the only lasting raw material for tools with which he was acquainted; that he knew how to light a fire; that he believed in a future state for his soul, however vaguely he may, in his rudimentary psychology, have understood this matter. Thus he was a man in every sense of the word and would have been recognised anywhere to-day as such, were he to appear in flesh and blood in the streets of any great town.

Branco, the eminent palæontologist, said in 1901 that in the history of our planet man appears as a genuine *Homo novus* and that, as to his ancestry, palæontology tells us nothing on the subject—it knows no ancestors of man.[2]

[1] "Der gegenwärtige Stand der Abstammungslehre," Der Türmer, v. October, 1902, Part I, p. 13, *teste* Wasmann, "Modern Biology," p. 480.
[2] See Wasmann, "Modern Biology," pp. 477–8.

From the time of Darwin scientific observers have been looking for what has been called "the Missing Link," but have never succeeded in finding him. Sometimes he has been thought to have been secured, as in the case of the Neanderthal and, later on, of the Trinil, Heidelberg and Piltdown remains ; but none of these give much assistance to the seekers. Further investigations may throw light upon all these things, but at the moment, those who have written on the Piltdown skull, the latest discovered memorial of early man, are not in any way agreed as to how it should be restored, what it would be like when properly restored, nor what its cranial capacity may have been. Further investigations may throw light on this matter. They may, though for reasons yet to be given, it seems unlikely, afford distinct—possibly even convincing—evidence in favour of the common origin of man and mammals. So far the proof is not there from the skeletal point of view. Of course there are the fantastic pedigrees of Haeckel, with numerous purely imaginary ancestors inserted wherever the gap was too huge to be ignored. No one credits these things nowadays ; indeed the old phylogenetic legends day by day tend to become regarded with less and less favour and to have less and less weight. Driesch, as we have seen, does not hesitate to criticise with the utmost severity "the phantasy christened Phylogeny."[1] Bateson derides the same system :[2] "Naturalists," he says, "may still be found expounding teleological systems which would have delighted Dr. Pangloss himself, but at the present time few are misled."[3]

All these phylogenetic legends arose from the obsessing idea of series which Mendelian investigations have shown to be almost certainly fallacious.[4] Fallacious or not, there is nothing at this moment resembling a series in connection with man during the ages of his existence upon the earth,

[1] See his "History of Vitalism," p. 140, and elsewhere.

[2] In his "Presidential Address to the British Association in 1914," I, p. 8.

[3] He quotes, as an example of these, from a recent Croomian Lecture, "On the Origin of Mammals," which shows high powers of imagination : but it is a small thing in comparison with the Haeckelian pedigree of man.

[4] See p. 363 for Bateson's discussion of the sweet-pea and its varieties.

nor is there any series linking him up with any possible ancestry which he may have possessed.

A good many of the ideas about man and his ancestry are built upon the unsafe foundation which was laid down when it was considered to be a canon of science that evolution proceeded only by the gradual accumulation of small variations. Were this the case we might reasonably expect to be presented with a "series," if man's body had been evolved from that of some lower mammal. But we have seen that the "small variation" and "gradual accumulation" theories do not hold the field as they did. One of the potent arguments against such a method of evolution is that a slight modification or an accumulation of slight modifications might very well reach such a point as to be actually disadvantageous to their possessor, before they could reach that further point where they might be really beneficial to him in the struggle for existence. It is no use for me to congratulate myself on the fact that, if I reach a certain spot, I shall be in complete safety and comfort, if on the way to that spot I must necessarily pass through an area where I shall almost certainly be destroyed, or, at best, be in much greater danger than at the spot from which I started. Now it so happens that this particular argument can be pressed home more fully in the case of man than perhaps almost anywhere else. Let us suppose, for a moment, that some ape-like creature is, slowly and by a minute series of changes, tending to a man-like form; what are the things which would have to happen in the process of his evolution? We will consider these in a moment; but while we are doing so, let us not fail to note that with one single exception, there is not one of the things which must have happened that would not have been of such a character as to have placed the ape-like creature, in the early stages of his evolution, in such a position of disadvantage amongst his fellow-animals as inevitably to have led to his early extermination.

Man is weaker, less agile, less fitted for rapid flight, less well-clothed with hair, less well provided with strong canine teeth, in every physical way a poorer, less powerful animal than, say, a gorilla. Now, *ex hypothesi*, he gradually attained

to this position of physical disadvantage by slow degrees: is it likely that he would have survived the process? The late Professor Dwight sums up this point so well that I shall quote him *in extenso*.[1] Speaking of man, he says: "Not very strong of arm, not very swift of foot, without a well-developed hairy hide, or large teeth, or strong claws, he seems as a mere animal an exceedingly unfortunate one, good neither for attack nor defence, in short very unfit for the struggle for existence, in that imaginary period of half-fledgedness between brute and man. His instincts and his senses, that of touch perhaps excepted, though in the savage state undoubtedly greater than those of civilised man, are by no means remarkable. Take him as a mere animal, what is he but an egregious failure? By what kind of evolution could such a creature rise who shows throughout his body only instances of the survival of the unfittest? Let us try to imagine him rising in the scale according to the dogmas of evolution. Let us watch the arboreal monkey, well-fitted for his surroundings, gradually losing all that fits him for them. We see his coat growing thinner, his arms shorter so that he loses his "reach," his legs longer so that climbing becomes harder, and at the same time his brain growing in some incomprehensible way, and for no good reason, excepting that it is necessary for the theory to believe that the brain-development went on so swimmingly that it compensated for the physical degeneration."

There is of course one thing, and one thing only—the "exception" spoken of a few lines above—which has given man his predominance and enabled him, poor creature though he is physically, to lord it over all other living things. That one feature is the mental superiority which enables the weak to overcome the strong. Now that form of psychology, rapidly becoming extinct, which adhered to the foolish theory that the brain secretes thought as the liver secretes bile, was (and is, so far as it exists) constrained to postulate an early and, as Professor Dwight put it, "incomprehensible" development of the brain. Some theorists hold or held that, for some reason unknown and unguessed at,

[1] "Thoughts of a Catholic Anatomist," Longmans, New York, 1911, p. 158.

man's brain began to grow because he began to assume the erect posture, though it is not shown how the one event depends upon the other. Other theorists hold an opposite and equally unproved view that he took to the erect posture because his brain began to grow. All these ideas are the purest surmises; there is not a shred of evidence for any one of them. The fact is that the "small variation" and "gradual accumulation" theory breaks down in detail and hopelessly, as far as man is concerned, when it comes to be critically examined. Many zoologists to-day consider that it has equally broken down in other cases with which we are not now concerned. This method of explanation having failed, is there any other which can be put forward? Yes: recent science suggests that the theory of gradual evolution may be supplanted by that of saltation or mutation. According to this view a new organism *considerably* different from the parental type is, from time to time, suddenly originated by unknown causes, and perpetuates itself as a new species. If adopted merely as a working hypothesis to account for the common origin of the bodily part of man and the lower animals, this might possibly lessen some of the difficulties, even from the purely rational standpoint. Some special intervention or supernormal causation would have been required in any case to produce an organism with brain and nervous system fitted for the reception of a rational soul. From the scientific point of view such mutations in the course of descent are not only conceivable but seem to have been proved, by the observations of de Vries, to have occurred in at least some species of plants.

The hypothesis of the development of man's body by one or more considerable mutations, designed to take place so as to provide a proper habitation for the human soul, would also from the scientific point of view raise fewer difficulties than the older theory of the accumulated small variations. There is this final point to be remembered, namely, that whilst it might have been conceivably possible, under the older theory, to find a "series" which would establish the common origin hypothesis, such a series could not exist and could scarcely be expected to exist, under the

saltation theory. Hence the difficulty concerning the "missing link" disappears. Hence definite proof that things had happened in that way is perhaps scarcely to be looked for, even if it were in that way that things did actually happen. But the real fact is that, whatever surmises we may make, we *know*, as Reinke has asserted, "nothing about the origin of man."

So much for the hypothesis of the evolutionary formation of the first man's body, if assumed by scientific investigators simply as a working hypothesis to co-ordinate and rationalise certain morphological and physiological facts. How does it stand as a legitimate doctrine of Catholic belief? Mivart, as is well known, first proposed in 1871 the view that Adam's body may have been mediately created—that is formed by God not directly from the dust of the earth, but indirectly by Him through the agencies of evolution acting on the lower animals. What is the present position of that doctrine? Is it compatible or is it incompatible with the teaching of the Catholic Church? The reply to this question is complex and needs accurate distinctions. I learn from competent theologians that the present position may be summed up somewhat as follows.

Mivart's theory was somewhat precipitately and over-confidently advocated last century by certain able theological writers who were much impressed by the rapid advance of the Darwinian theory. Apparently their writings were brought under the notice of the Roman ecclesiastical authorities and were disapproved by them: as a consequence the authors in question retracted their advocacy of the doctrine and matters were allowed to remain there. Accordingly the present position is this: The mind of the Church at the present time, as expressed in general in the common teaching of theologians and as conveyed by the communications of the ecclesiastical authorities at Rome to the writers above alluded to, is adverse to the theory of Mivart. In addition to the more obvious meaning of the Biblical text, the commentaries of the Fathers, the language of St. Paul and the intricate manner in which various theological dogmas have been extrinsically connected with or illustrated by the literal interpretation of the Scriptural

account of the creation of Adam, have all combined to make the authorities entrusted with the guardianship of the Church's teaching very reluctant to admit that a new interpretation of a very important passage of Scripture *may be freely taught*, when there is no clear proof—which is the case up to the present—that such an interpretation is necessitated by actual facts of incontrovertible significance. Such necessity can scarcely arise until Science is in a position to withdraw the statement that she knows "nothing about the origin of man."

The right and befitting mental attitude of the Catholic then, in regard to this doctrine, is clear. He does not limit his assent to the minimum of what is rigidly defined as *de fide*. Whatever may be the attractiveness of the speculative opinions of philosophers, or of the working hypotheses of men of science—whatever even may be their convenience or instrumental utility in advancing human knowledge—the loyal Catholic will constantly seek to adapt himself to the mind of the Church and will accept her guidance even where her teaching is not put forward as infallible or irreformable. Still, while this is true as to the filial duty of her children, it is on the other hand supremely important in the interests of the Catholic Church herself and of her infallible utterances, that the degree of authority, the nature of the certainty and the character of the sanctions attached to diverse ecclesiastical pronouncements on such questions, should be accurately appreciated. A moment's reflection on the possibility of future scientific discoveries, coupled with the experience of the Galileo episode, makes this obvious.

Returning, then, to the question of the present theological position of Mivart's hypothesis respecting the possibility of the formation of Adam's body by divinely directed evolution, we find that although the advocacy of this theory has been discouraged by the Roman ecclesiastical authorities as above indicated, it has not, down to the present, received any public official censure from any of the Roman Congregations—still less has it been condemned as heretical through the formal definition of the opposite doctrine as *de fide*. Hence should real proof of the original evolution

of man's body ever come to light—which does not seem likely at present—the Church would have no difficulty in accepting that opinion, as she is not committed in any irrevocable manner to the opposite doctrine.[1]

[1] The theological friends whom I have to thank for the substance of the latter part of this chapter inform me that those desirous of studying the most recent exposition of this matter may be referred to Van Noort, "De Deo Creatore," pp. 114 *et seq.*

CHAPTER XXXVIII

MAN AND HIS ORIGIN—HIS SPIRITUAL PART

IN the preceding chapter we saw that the dual origin of man, as described by the Bible, not to speak of the obviously dual aspect from which he must be regarded, necessitated subdivision when he and his origin came under consideration. Naturally we began with the lower or corporeal part and we have now to turn our attention to the higher or spiritual.

And here a few prefatory remarks may not be out of place. It is not to be doubted that that often-quoted individual "the man in the street," when he thinks about Catholics at all, thinks of them in a general kind of way as a mind-enslaved body of people, shut up in a close cage of dogma from which it is dangerous even to look out, and utterly impossible to protrude so much as a finger. Persons—better educated and informed than "the man in the street" generally gets the credit of being—will be found obsessed with the idea that everything theological is with us a closed question; that nothing is left for discussion nor is there any room for difference of opinion. How absurd and how ignorant this is need not be pointed out to those who belong to the Household of Faith and who take the trouble to know something about the religion which they profess. As a matter of fact the number of things which a person must believe or cease to be a Catholic—the things which are defined as *de fide*—are far fewer than the "man in the street" has generally thought.

This is not a treatise on Dogma, nor does it propose in any way to encroach upon that ground. But of course there are dogmas which every Catholic must hold or cease to be a Catholic; one of these is the existence of God and

His Creation of the world, another is the possession by each person of an immortal soul created by God Himself.

Now it must be obvious to the most casual reader that there are, outside our Church, quite a number of persons who deny one or other of these dogmas and indeed all other dogmas. If we go down to first principles, we shall probably find that some of these start from the opinion that nothing can be known: for such there is no hope, since they commit intellectual suicide. There are others—the true agnostics—who, without going so far as this, still think that it is impossible to have any real knowledge of the fundamental and first causes of things as they are; who are content to take them as they are and make a study of them as a going concern, satisfied to watch the machine at work without enquiring too curiously how it came to be in operation. Now, as regards the question of the origin of things, we have tried to show that, apart altogether from revelation, the creation hypothesis does explain matters otherwise left unexplained. It is, in fact, the only reasonable and tenable explanation yet put forward and the sole alternative to blank scepticism or the more modified form of agnosticism. Yet we are perfectly satisfied to rest our belief on revelation, in this matter as in others. And so with the doctrine of the human soul; whilst the Catholic is content to accept the fact on the strength of revelation, it can certainly not weaken his faith and will undoubtedly help him to give that reason for it which is recommended by the Apostle, if he learns that the dogma which he has been brought up to believe, or has come to believe, here as in the case just quoted, does afford, even in the opinion of writers to whom the voice of revelation in no way appeals, the most satisfactory, indeed the only satisfactory explanation of things as they are.

It is not now suggested that all of these writers, some of whom will shortly be quoted, perhaps any of them, would agree with us as to the attributes, still less as to the origin of the human soul, though they postulate the existence of such a thing. In a previous discussion we saw (p. 289) that a decision as to vitalism was reached largely by a process of exclusion. In a similar way, and also by a process of

exclusion, some of these writers have arrived at a conclusion in favour of the existence of a soul, a theory now called by them Animism.[1]

It has already been mentioned that the late A. R. Wallace, who was the co-discoverer—perhaps one had better say co-formulator—with Darwin of Natural Selection, was quite clear that there were "three stages in the development of the organic world when some new cause or power must necessarily have come into action."[2] The first of these occasions was when the first living cell came into existence: the second was the moment of the introduction of sensation or consciousness, when the animal and vegetable kingdoms became separated from one another: the third was the differentiation of man from other animals, by his possession "of a number of his most characteristic and noblest faculties, those which raise him furthest above the brutes and open up possibilities of almost indefinite advancement. These faculties could not possibly have been developed by means of the same laws which have determined the progressive development of the organic world in general, and also of man's physical organism."

In expressing the opinion that man possesses amongst his higher attributes, characteristics which could not possibly be of service to him for purposes of survival—which might even be disadvantageous from this point of view and which could not, therefore, come under the operation of Natural Selection—Wallace agreed with Huxley, who was obliged to admit that such things as a love of beautiful scenery or of music, indeed the whole gamut of artistic interests, had no survival value and could only be spoken of as "gratuitous gifts."

Now it is quite clear that the transport of joy into which the sight of a magnificent prospect will throw the properly tuned observer cannot possibly be of any assistance to him

[1] To avoid any confusion it should be pointed out that the term "Animism" is used in two very different senses. Here, and in the writings of the persons alluded to above, it is employed as a term connoting the belief in the existence of a soul in man. But it is also used by anthropologists to connote beliefs met with very commonly amongst savage races as to which nothing need here be said.

[2] "Darwinism," London, Macmillan & Co., 1889, pp. 474 *seq.*

in the struggle for existence. It might even be directly disadvantageous, since it might divert his attention from the machinations of his foe at the critical moment and thus lead to disaster. Hence it—and of course other similar æsthetic pleasures—cannot come under the operation of Natural Selection. We have already seen that a large number of biologists would be unwilling to assign to Natural Selection an importance so great as Wallace, very naturally, attached to it. Still it may fairly be said that if Natural Selection cannot—as admittedly it cannot—account for these things, much less can any other purely materialistic theory as yet promulgated.[1]

Wallace, then, came to the conclusion, apart altogether from any recourse to revelation, that man's mental characteristics could only be accounted for by the fact that he possessed what we agree to call a soul; nor is he by any means the only one who has arrived at this conclusion and by a similar method of reasoning. Without unduly multiplying instances of the evidence from outside the ranks of Catholicism I may draw particular attention to a very remarkable work which recently appeared.[2] Dr. McDougall admits that he approached his subject with no prejudice in favour of the doctrine of a soul, but rather with that distinct leaning to the opposite pole of thought which still lingers as a legacy from the materialistic days of the Victorian era. He even makes a half-humorous apology for

[1] Wallace in the Preface to "The World of Life," London, Chapman & Hall, 1910, complains that he was accused of dishonesty for his adoption of anti-materialistic theories and adds: "I also wish to point out that, however strange and heretical some of my beliefs and suggestions may appear to be, I claim that they have only been arrived at by a careful study of the facts and conditions of the problem. I mention this because numerous critics of my former work—' Man's Place in the Universe ' (to which this may be considered supplementary)—treated the conclusions there arrived at as if they were wholly matters of opinion or imagination and founded (as were their own) on personal likes or dislikes, without any appeal to evidence or to reasoning. This is not a method I have adopted in any of my works." It will be remembered that Haeckel tried to belittle Virchow (a much greater man of science) when he was unable to confute the arguments of that very distinguished anthropologist.

[2] "Body and Mind," by Dr. McDougall, F.R.S., a medical man who is Reader in Mental Philosophy in Oxford. London, Methuen & Co., 1911. I very strongly commend this book to readers desirous of following a complete and exhaustive consideration of the whole of this subject from a standpoint outside that of religion and revelation.

the opinion at which he has arrived when he says, as he does in his preface, that "to many minds it must appear nothing short of a scandal that anyone occupying a position in an academy of learning other than a Roman Catholic seminary should in this twentieth century defend the old-world notion of the soul of man." Yet, after a most prolonged and careful examination of all the alternative solutions, he finally gives his verdict in favour of the existence of the human soul, on the lines familiar to Catholics, in and out of seminaries.

Any adequate discussion of this question is impossible in this book: all that can here be attempted is to set out briefly the Catholic view and to indicate equally briefly the line of argument in opposition to what are commonly called monistic views.[1]

In the first place it will be well to make clear what the Catholic means—perhaps still more what he does not mean—by the soul, and what is his idea as to its relation to the body. The "Catholic Encyclopædia"[2] defines the soul of man as "the ultimate internal principle by which we think, feel, and will, and by which our bodies are animated." The soul is not to be thought of as detached from the body, or as located in any special portion of the body. A good deal of confusion as to the proper ideas concerning it arises from Descartes' theory that the soul was located in the pineal body—a small mass of tissue, often containing a calcareous deposit, near the centre of the brain.[3] Descartes' idea is absurd—as absurd as the ignorant remark said, but surely untruly, to have been made by some man of science, that he refused to believe in the soul because he had never been able to expose it with his scalpel.[4] The soul is a simple,

[1] Those who desire to pursue the matter further may be referred to Fr. Maher's work on Psychology, published in the Stonyhurst Series, by Messrs. Longmans.

[2] *Sub voce* Soul. The writers of the article are Frs. Maher and Boland.

[3] Morphologists have claimed that it represents the third eye found in certain lizards, but its physiological significance, if any, is at present unknown.

[4] *Ex hypothesi* the soul leaves the body at the time of death so that, even if it were material, which it is not, the anatomist could hardly expect to find anything but its prison, not itself. But though the story is probably apocryphal, the sort of argument implied in it sometimes has a certain effect upon shallow and ill-educated minds, and deserves passing mention here.

unextended substance which in scholastic language acts as the "Form" of the body. We have already considered (Chapter IX) what is meant by Matter and Form, and have seen that it is conceived that Matter can never exist without Form. Form can exist by itself in the case only of the higher forms, "*formae spirituales*," such as angelic spirits and the human soul, these being spiritual and immortal. Otherwise Form cannot exist by itself, and Matter and Form may be looked upon as inseparable. If then the Soul be the Form of the body and Matter cannot exist without Form, what happens at death, when the soul escapes from its life-long prison? Here the scholastic philosopher has recourse to the further theory of subsidiary forms. When the soul leaves the body and this ceases to be a living thing, the subsidiary and latent chemical "forms" of oxygen, nitrogen, carbon and the rest pass from *potentia* to *actualitas* in the material constituents of the dead body. We can see this for ourselves, or rather we can see the effects of it. What guards the body from corruption and prevents the chemical constituents thereof asserting themselves and destroying it, as they promptly proceed to do after death has taken place? It is the soul or dominant "form" which overrides them and forbids them to act until its influence is removed.

These minor and subsidiary forms are, of course, there all the time but *in petto*, "stopped down" so to speak like the hidden characteristics under the Mendelian doctrine—when the Master-form is gone the "stopping-down" ceases and the lesser *formae* come into operation.

Yet, as the Form of the body, the soul, though unextended, pervades the whole body and makes it what it is. Such is the Catholic view; when it is rightly understood, it is also in a true sense a monistic view, since the Soul and the Body, the Form and the Matter, make up one single thing. "Though the philosophers of former days were unaware of all the departmental details of brain activity, they understood as well as we do the essential point, that in our composite nature soul and body form *one* being, whose every operation is of mixed character like itself. The soul alone is the intelligent principle, yet all objects of knowledge

must come to it through sense, and in the senses it can be reached only by the mechanical media of light or sound or touch. So firm was their grip of this principle that the Schoolmen styled the soul the 'substantial form' of the body, and in their mouth this term expressed a union more essential and intimate than modern philosophers can perhaps imagine."[1]

We leave the question of the Catholic idea of the human soul with the final remark that it is patent that some of those who write most glibly on the materialistic side have never taken the trouble to master the Catholic view of the matter. It is also clear that some of those who from outside have unconsciously adopted the Catholic view on this point are only dimly aware, if aware at all, that the ideas which they set forth have been known to and adopted by Catholic philosophers for centuries past.

[1] Gerard, "The Old Riddle and the Newest Answer," London, Longmans, 3rd ed., 1907, p. 132. There is a sixpenny edition of this admirable answer to the Haeckelian "philosophy."

CHAPTER XXXIX

MAN AND HIS ORIGIN—HIS SPIRITUAL PART
(*concluded*)

HAVING studied the Catholic view of the soul, we may briefly turn our attention to some opposition theories, commonly called monistic, in opposition to our view, which some of our opponents describe as dualistic. Of the falseness of this description we have spoken in the last chapter. The views we are now to consider are called Monistic because they reduce everything in man to a single explanation or fact, instead of postulating a Soul and a Body, however closely united.

Of Monism there are two great forms with numerous subforms, for an account of which readers must be referred to more voluminous and specialised works than this. There is Idealistic Monism and Materialistic Monism, as to both of which a few words must be said.

Idealistic Monism has been already touched upon in the earlier pages of this book (p. 8). It gets over the difficulty as to the relation between the body and the mind by boldly denying that there is any such thing as matter outside the mind: thus the seemingly independent material world is to be looked upon as an illusory creation or emanation of mind. Further, this doctrine teaches that all minds are really one, all being drops in the great ocean of universal consciousness. On hearing things thus stated and learning that, according to this school, there is no such thing as matter, the "man in the street" will probably be tempted to answer as contemptuously, and, it may be added, as ignorantly, as Dr. Johnson did when Boswell propounded to him Bishop Berkeley's idealistic solution. "After we came out of the church we stood talking for some time together of Bishop Berkeley's ingenious sophistry to prove the non-existence

of matter, and that everything in the universe is merely ideal. I observed, that though we are satisfied his doctrine is not true, it is impossible to refute it. I never shall forget the alacrity with which Johnson answered, striking his foot with mighty force against a large stone, till he rebounded from it, 'I refute it *thus*!'"[1] Nevertheless the fact is that our own personal experience teaches us that I am I, and that my personality is mine and no one else's. Further, if I am to admit that there are other men, I must accept the fact from them that their experience is identical. These things place the idealistic theory in direct conflict with our experience—the one thing in the world which we know best. Looked at from this point of view the impulse of Johnson and of the "man in the street" is justifiable. But it does not dispose of the question, for the theory has its reply to many of the objections brought against it.

We may say, for example, that a dose of strychnine secretly and without his knowledge administered to a man and, therefore, never mentalised by him, will nevertheless kill him; and we may ask whether, in face of this fact, it is possible to argue that the strychnine has not extension and a real existence. The reply would seem to be that the strychnine—and all other things—are present to the mind of the Universal Consciousness and so far have such existence as things can have. From the idealistic standpoint this no doubt is an answer; but it involves a further question, which cannot so easily or indeed satisfactorily be solved. For if all consciousness is part of the Universal Consciousness, which is a pantheistic solution: then either there is no such thing as Sin, or the Universal Consciousness is sinful or at least partakes of the nature of Sin.

Since the latter horn of the dilemma is unthinkable, the former must be accepted. According to this there is no such thing as sin; there is only imperfection. The seducer of innocent children, "the smilere with the knife," the traitor—these are not sinners; they are only low down the ladder of perfection. Since in the last analysis, under its teaching

[1] Boswell's "Johnson," ed. Birrell, Vol. II, pp. 133–4. Of course neither Berkeley nor any other philosopher of his school ever denied that man has the *sensation* of solidity.

the blackest crime is at least situated upon the pathway of good, this system would seem to exclude any idea of morality from its scheme, and thus to pronounce, from the ethical point of view, its own condemnation.

Materialistic Monism in its simplest expression teaches just the opposite—namely, that there is no mind, but that matter, looked at from the other side, so to speak, is possessed of consciousness. As has already been stated (Chapter XII) this point of view was admirably put by two great physicists when declaring it to be an utterly untenable theory.[1] These two authorities are dead, but the doctrine which they derided is not, for it is precisely that which has been put forward by Haeckel. As summarised by Wallace, this theory teaches that "matter," i.e. the material universe, is infinite, that so is the "ether"; that they fill infinite space, and that both are "eternal" and both are "alive."[2]

It is further argued by the materialistic school that the brain, without a soul, is capable of explaining all the psychological problems of life. We have seen that some have even spoken of thought as secreted by the brain in the same way that bile is secreted by the liver—the absurdity of this remark clearly appears when it is remembered that bile, like all other secretions, is extended or material, which thought being spiritual most assuredly is not; this absurdity has led to the position now being regarded as untenable. Yet the idea which underlies this statement is necessarily that of the materialistic monist. It is the brain, the actual grey and white matter of the brain, which thinks: it must needs be, since there is nothing else to think. Yet men of

[1] Stewart and Tait asserted, as quoted in Chapter XII, that "the only reasonable and defensible alternative" to their hypothesis of the soul was "the stupendous pair of assumptions that visible matter is *eternal* and that IT IS ALIVE"—a pair of assumptions which they laughed to scorn. (Italics and capitals as in original.)

[2] "The World of Life," p. 7. Wallace adds that "none of these things can possibly be *known*, yet he (Haeckel) states them as positive *facts*." And, he adds, this is "surely not *science* and very bad philosophy." Haeckel's exact statement is that "the two fundamental forms of substance, ponderable matter and ether" (which, by the way, is a distinction without a difference according to physicists of to-day), "are not dead and only moved by extrinsic force, but they are endowed with sensation and will." See Gerard, "The Old Riddle," for a full discussion of Haeckel and his views.

science, with and without any leaning towards revelation, have proclaimed their belief that so great a gulf exists between the mechanical processes of sensation and rational perception—not to say thought and more especially abstract thought—as to be utterly impassable. Thus Tyndall in 1868 in his address at the British Association, said that "the passage from the physics of the brain to the corresponding facts of consciousness is unthinkable. Granted that a definite thought and a definite molecular action in the brain[1] occur simultaneously, we do not possess the intellectual organ, nor apparently any rudiments of an organ, which would enable us to pass by a process of reasoning from one to the other. They appear together, but we do not know why. Were our minds and sense so expanded as to enable us to see and feel the very molecules of the brain, were we capable of following all their motions, all their groupings and electrical discharges, if such there be; and were we intimately acquainted with the corresponding states of thought and feeling, we should be as far as ever from the solution of the problem—'How are these physical processes connected with the facts of consciousness?' The chasm between the two classes remains still intellectually impassable." It is now nearly fifty years since these words were uttered, fifty years of more strenuous scientific research than the world has ever previously known: yet the statement embodied in them remains as absolutely true as it was on the day on which the Address was delivered.

The crowning difficulty alluded to therein may be supplemented by yet another difficulty which has been discussed in another connection in a previous chapter. This is the want of agreement between the theory in question, that the brain alone is responsible for thought, and the actual and undisputed anatomical facts. Let us look more closely at this point. Human beings and the higher mammals, indeed all mammals, are, anatomically speaking, constructed upon similar, indeed one might say identical, lines; from this point of view their differences are of degree not of kind. Thus, all have a vertebral column, a central nervous system, highly similar arrangements of muscles, nerves, blood-

[1] Which, by the way, still remains unproved.

vessels and so on. Further, and in this connection far more significant, the brains of man and of all mammals conform to a similar plan, possessing a two-lobed cerebrum, a cerebellum, a medulla and so on, even agreeing in far more minute details. On these points all anatomists are agreed. Thus the brain differs only in degree and not in kind from that of other mammals, and as regards the higher apes differs but little even in kind.

Now if " the brain secretes thought as the liver secretes bile," how is it that there is such a wide difference, such an impassable gulf between the brain-secretions of man and the apes and so very trivial a difference between—say, their liver secretions ? We may develop this point a little further.

The elephant has a larger brain *absolutely* than a man. Yet, though no doubt the elephant is a wise beast, he is certainly not the mental superior of man. Hence it cannot be absolute size of brain which is correlated with thought, nor can it be relative size, for the relative size of man's brain is less than of some of the smaller birds. If size has nothing to do with it, can it be the thickness and complexity of the convolutions, the ridges, separated from one another by furrows, into which the surface of the brain is thrown ? Can it be the amount of grey matter which it possesses or the percentage of phosphorus which it contains ? It may at once be said that there is no evidence in support of the materialistic theory to be obtained in any of these directions ; indeed we may rest assured that facts in no way fit in with the theory.

Take the brain of the anthropoid ape. It may at once be admitted that its anatomy most closely resembles that of the human brain. What then ? Does that advance in any kind of way the materialistic argument ? Quite the contrary. One remembers the time—it is almost incredible to think of it—when it was really thought that the reverse was the case, and when people seemed to imagine that supreme importance was attachable in this connection to the question as to whether an ape had or had not in his brain that anatomical object known as the " hippocampus major." Kingsley in his " Water Babies " satirised this absurd state of mind so well that the passage will bear quotation. Speak-

ing of one of his characters, he says: "He had even got up once at the British Association, and declared that apes had hippopotamus majors in their brains just as men have. Which was a shocking thing to say; for, if that were so, what would become of the faith, hope and charity of immortal millions? You may think there are more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers, and other little matters of that kind; but that is a child's fancy, my dear. Nothing is to be depended upon but the great hippopotamus test. If you have a hippopotamus major in your brain, you are no ape, though you had four hands, no feet and were more apish than the apes of all aperies."

Here you have two brains—two musical instruments, let us say—not very markedly dissimilar from one another so far as even a minute examination can show—which, in a word, differ and that only slightly; in degree and not in kind. Yet one of these can produce heavenly music, whilst the other can never rise above jangling discords. Surely there must be a difference somewhere: if it is not in the instruments, it must be referred to the performers thereon. With a quite reasonably good brain, from the morphological point of view, with a brain not so very inferior anatomically to that which Aristotle and Shakespeare possessed, the ape remains still the aimless ape of "The Jungle-Book," far less intelligent even than animals not so well provided, from the cerebral point of view, as he is. Size of brain in a comparison between man and mammals, then, has nothing to say to the question of intelligence. Nor has it in a comparison between man and man. Since there is no reason to doubt that his cerebral cavity was occupied by brains and not by water, and since we know that palæolithic man had as large a brain mass and in some cases larger, than we have, we must, if brain-mass be everything, admit that he was a man of higher intellect than his degenerate descendants of to-day. Of course he may have been so and only repressed by lack of opportunity, but, if so, what an anti-evolutionary argument is that! It has already been pointed out that Gambetta—no fool, whatever else he may

have been—had a singularly small brain: a dwarf with a brain about the size of that of a large dog may have complete intelligence and be able to speak several languages.

All these things show that the theory which teaches that it is the brain which thinks and nothing higher than the brain does not fit in with the facts of anatomy as now very fully known to us. If the anatomical facts seem to negative the materialistic conclusions so popular in the Victorian era, what is to be offered in their place?

Writers, as we have seen, who are unaffected by the teachings of revelation, are now returning to the temporarily discarded theory of the soul which the Catholic Church has ever held. We began by stating that for the Catholic the question of the existence or non-existence of the soul was closed. The object of this and the preceding chapter has been to show that, supposing it were not a closed question, this theory still would have to be accepted as the only rational explanation of the facts which have to be taken into consideration.

This may be emphasised and the matter brought to a conclusion by briefly summarising the conclusions recently arrived at in the most important book of its kind which has appeared in late years, viz. that of Dr. McDougall, already mentioned.[1] After showing that the decision lies between Parallelism (a form of Materialism) and Animism (the doctrine of the Soul) he proceeds to show that "the mechanical principles are not adequate to the explanation of biological phenomena, neither the phenomena of racial evolution nor those of the development of individual organisms, nor the behaviour of men and animals." Further, from the psychological point of view, "evidence was adduced which conclusively proves that a strict parallelism between our psychical processes and the physical processes of our brains does not as a matter of empirical fact obtain; and it was shown that facts of our conscious life, especially the fact of psychical individuality, the fact of the unity of the consciousness correlated with the physical manifold of brain-processes, cannot be rendered intelligible (as admitted by leading Parallelists) without the postulation of

[1] "Body and Mind," pp. 355 *seq.*, Methuen, 1911.

some ground of unity other than the brain or material organism." "The empirical evidence," he concludes, "seems to weigh very strongly against Parallelism and in favour of Animism."

Dr. McDougall further points out that though, whichever horn of the dilemma we accept, we find ourselves with unsolved difficulties before us and with strange consequences forced upon us, yet "Animism has this great advantage over its rival, namely, that it remains on the plane of empirical science, and, while leaving the metaphysical questions open for independent treatment, can look forward to obtaining further light on its problems through further scientific research. It is thus a doctrine that stimulates our curiosity and stirs us up to further efforts; whereas Parallelism necessarily involves the acceptance of metaphysical doctrines which claim to embody ultimate truth and which set rigid limits to the possibilities of further insight into the nature of the world, and it finds itself forced to regard certain of its problems as ultimately inexplicable.

"Finally, we have seen that Parallelism rules out all religious conceptions and hopes and aspirations, save those (if such there be) which are compatible with a strictly mechanistic Pantheism—a Pantheism which in no way differs from rigid Materialism in respect to practical consequences for the life of mankind; whereas Animism in this sphere leaves open the whole field for further speculation and inquiry, and permits us to hope and even to believe that the world is better than it seems—that the bitter injustices men suffer are not irreparable; that their moral efforts are not wholly futile; that the life of the human race may have a wider significance than we can demonstrate; and that the advent of a 'kindly comet,' or the getting out of hand of some unusually virulent tribe of microbes, would not necessarily mean the final nullity of human endeavour. These," he concludes, "seem to me to be overwhelmingly strong reasons for accepting, as the best working hypothesis of the psycho-physical relation, the animistic horn of the dilemma." With this summary of the conclusions of this remarkable book we may end this section.

CHAPTER XL

A FEW FINAL CONSIDERATIONS

THE topics with which this book is concerned having now passed under consideration, and such attention as was possible having been bestowed upon them, it only remains to emphasise some of the points to which attention can hardly be too much directed, since it is owing to a neglect of these considerations that people form false and dangerous ideas as to science and, it may be added, as to religion also.

In the first place, then, let us get firm hold of the fact that with the legitimate field of science religion has nothing whatever to do, and should not, and we believe does not, wish to interfere. By the field of science we mean the field of observed facts, a thing apart from religion. It is when scientific men begin to philosophise that conflict may arise. It is well to emphasise the word *may*, for here again it may safely be said that ninety-nine per cent of the philosophisings of science do not in any way come in contact with theological considerations: when they do so it is well to remember what these philosophisings amount to.

It is of the first importance not to be led away by the hot-gospellers of the daily and weekly press, or by the enthusiasms of ardent and sometimes ignorant disciples. It is equally of the first importance to remember that these philosophisings are working hypotheses and nothing more—perfectly legitimate as working hypotheses, often useful to the progress of science, but not to be held up to us as facts which we are compelled to accept. For example: anatomists tell us that the bodily construction of men and apes is almost identical: that is a positive fact which can be proved to demonstration and theologians have no

reason to dispute it, nor the slightest desire to do so. But when an anatomist comes along and says: "This similarity and certain other facts known to us show that men and apes have had a common ancestor," it is fair to reply that while the matter *may* be as suggested, it is equally true that it may not, since it is perfectly clear that what is alleged as proof in no way amounts to what is required for purposes of demonstration. Hence the theologian is acting well within his limits when he says: "You have by no means proved that point: until you do, you cannot expect me to believe it nor, what is more, can you expect me to teach it nor to approve of its being taught as fact." Further, he might reasonably add, that all history teaches us that things have been constantly put forward as true which were afterwards withdrawn as having no sufficient foundation. This is the second point which we have to bear in mind: scientific theories are always coming and often going. Nor is this only the case to-day: it has been so ever since men began to work at science and to form scientific hypotheses. Horace Walpole, whose letters have been the delight of so many readers besides those for whom they were originally designed, was no doubt an airy trifler, but no one will deny that he was a shrewd observer of men and things. In a letter to the Earl of Strafford[1] he writes, after alluding to some rumour of an earthquake in London: "In my youth philosophers were eager to ascribe every uncommon discovery to the deluge; now it is the fashion to solve every appearance by conflagrations. If there was such an inundation upon the earth and such a furnace under it, I am amazed that Noah and company were not boiled to death. Indeed, I am a great sceptic about human reasonings; they predominate only for a time, like other mortal fashions, and are so often exploded after the mode is passed, that I hold them little more serious, though they called themselves wisdom. How many have I lived to see established and confuted! For instance, the necessity of a southern continent, as a balance, was supposed to be unanswerable—and so it was, till Captain Cook found that there was no such thing. We are poor silly animals: we live for an

[1] Dated August 6, 1784.

instant upon a particle of a boundless universe, and are much like a butterfly that should argue about the nature of the seasons, and what creates their vicissitudes, and does not exist itself to see one annual revolution of them." It is a hundred and thirty years since this was written; yet that lapse of time has only intensified its truth. If everybody had only remembered that working hypotheses are a necessity of scientific progress but are only hypotheses and nothing else and are just as likely as not to be discarded, almost all the trouble which has arisen in the past would have been avoided. Of course the trouble is mainly caused by the ignorant on both sides—by the scientific man ignorant of theology, its claims and its limits, and by the theologian too often in the past ignorant of what is meant by a working hypothesis. Misled by the outcries of popular writers, he is told that God and the Bible and religion are once and for all cast into outer darkness by the epoch-making theories of Professor X who, good, honest man, is in all probability not bothering his head in the least about theology but is trying to make one group of physical facts fit in with another.

These constant changes of opinion—and in our own time we have seen several of extraordinary significance—ought to teach us another lesson, the greatest that science can teach, and that is humility. If a hundred times things have been put forward as the last revelation of science and if on ninety-nine subsequent occasions it has been found that the supposed revelation was only a dream, let us on the one hundred and first occasion have the humility to say—as indeed most of the real learned framers of hypotheses have said: "This is a possible explanation of the facts to hand; let us see how it will fit in with later discoveries." It is abundantly clear that we are not familiar with anything but the fringe of science. Facts of all kinds are yet awaiting discovery, and when discovered it may be found that they upset some of our most cherished beliefs, as radium did. Moreover, of the most fundamental things, how little we really know! Take the nature of the ether and the electrical theory of matter—two, I suppose, of the most fundamental problems underlying the physical sciences. How much do

we really know about them—know, that is, as incontrovertible truth? I leave it to any physicist to reply. Or turn to the biological side: what about heredity and variation which underlie all the biological problems: how much do we really know about them? Honesty compels us to reply—Very little.

It must not be supposed that an attempt is here being made to belittle science, or the progress of science, or the work of scientific men. The present writer, whose life has been largely devoted to scientific work, is not going thus to stultify himself or his labours, such as they are. No: the progress of science during the last fifty years especially, has been something extraordinary. The briefest and most cursory survey of what has been done during that time would occupy a volume as large as this is, and even then would leave part of the story untold. But this advance has only opened the doors of new chambers of knowledge, and has shown us that, whether we consider the problems of the universe—of this little fragment of dust which we know as the Earth or of the most minute fragments of which it is composed, the atoms—we are confronted with problems which if they are ever solved, which seems doubtful, will never approach a solution during the lifetime of the infant of to-day, even if he lives to become a centenarian. Whilst, therefore, we learn humility let us also learn patience, especially those of us who are interested in the progress of religion. If we wait patiently we shall find that what has appeared to be threatening was not really so: it was either a cloud to be dispelled by the rising sun of knowledge or a familiar friend half seen in the darkness. Science is not a monster, as some ignorant people imagine, neither is religion a monster as other ignoramuses suppose. Let us be humble and let us be patient.

And above all, let us exhibit humility when we come to regard God as well as His creation. Catholics, of course, exhibit such humility in face of the mysteries of their Faith; but there is a kind of shallow mind, which thinks—and even sometimes says—that one should not believe anything one cannot understand—an attitude of mind which would certainly limit one's beliefs. It is only common sense to say

that if we could understand God and all His ways, either He would not be God or we should all be gods. Tennyson's philosophy on that point was accurate and sound :—

> "Flower in the crannied wall,
> I pluck you out of the crannies ;—
> Hold you here, root and all in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is."

The quotation may be hackneyed but it is none the less apposite.

Let us learn humility and patience from Science if we learn nothing else : but we shall miss its greatest lesson if it fails to teach us the greatness of the Creator, from whose Idea all these wonders took their origin.

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